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Report of the Committee of the Franklin Institute of Pennsylvania for the Promotion of the Mechanic Arts, appointed to ascertain, by experiment, the Value of Water as a Moving Power.

[CONTINUED FROM PAGE 154.]

No notice has been taken in the foregoing of the effect of the quantity of water delivered upon the velocity, the means having been deduced from all the apertures under a given head.

The velocity is, however, increased under a given head by an increase of quantity, a fact of the more importance because the velocity may be then increased without lessening the ratio of effect to power. The amount may be deduced from the following table.

TABLE ELEVENTH.

Showing the velocity of the wheel with different widths of aperture. Overshot No. I. *Taken from tables first and third.*

Width of aperture.	Velocities for maximum effects with heads of 2.75	2.25	1.25	1.25	0.75	Mean velocity.
Inches.	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
0.50	5.28		4.65			4.96
0.75		5.21	4.77			4.99
1.00	5.43	6.01	5.28			5.57
1.25	5.58	5.50	4.83	6.20	4.77	5.38
1.50				6.10	5.07	5.58

It is obvious that if in the above table the columns for each head were filled, the relation shown by the mean would be independent of the head. Although this is only partially true in the present case we are warranted by the general examination of the results for each head, and then by the average, in concluding that a slight increase of velocity results from increased quantity, the head remaining the same. If the mean could be implicity trusted it would prove a tendency towards a maximum, by its slow increase. The quantity being tripled, the increase of velocity is thirteen per cent., increasing from 1.00 to 1.13. This, as has been before shown, is with the buckets less than three-tenths full. If the quantity were much increased, other circumstances would become operative.

The fact just presented will be useful in practice where water is plenty, and it is desirable to have a particular velocity for the periphery of the wheel.

The conclusion from table tenth requires correction, but there is danger of error in departing from mean results. The following may serve to approximate toward the effect of varying the quantity upon the ratio of the velocity of the wheel to that of the impinging water. The mode of calculation is precisely the same as that for table tenth. The data are from table first.

TABLE TWELFTH.

Approximate corrections for the average results of table tenth.

Table A.	Head above gate.	Velocity of efflux. Aperture		Velocity of impact. Aperture		Velocity of wheel. Aperture		Mean ratio of veloc. wheel to veloc. impact. Aperture	
Number.	Feet.	0.50	1.25	0.50	1.25	0.50	1.25	0.50	1.25
5 & 14	2.75	7.91	7.52	10.34	10.10	5.28	5.58	.52	.55
18 & 31	2.25	7.18*	7.16	9.78	9.78	5.21	5.50	.53	.56
33 & 45	1.25	6.53	5.45	9.56	8.82	4.65	4.83	.48	.55
							Mean	.51	.55

* This number is for aperture .75, but no sensible error will result from its use here.

This table shews that with the lesser apertures the ratio of the velocity of the wheel to that of the water falls below the average ratio about four per cent., and with the larger rises as much above it. The ratio here is below that shown by table eleventh, viz., as 1.00 to 1.07, the apertures in this case being increased two and a half times, and in the former three times.

The second question under the general head 2, (p. 150) is in reference to the effect of the form of the gate through which water is delivered to the wheel upon the velocity of the wheel.

We have found, in discussing the effect of the different forms of gate used with this wheel, (see table eighth,) that, at a mean, the gate *b* discharged more water through a given opening than *c* or *a*, and *c* more than *a*. The proportions were as 85, 72, and 63, or as 1.35, 1.14, and 1.00.

From the conclusion drawn from tables eleventh and twelfth, it appears that as the quantities of water under a given head are increased, the velocity of the wheel increases, though not in the proportion of the quantities. It ought, therefore, to follow that the form of the gate should influence the velocity; a question easily determined by recurring to the first, second, and third tables, and their summary in table fourth.

As the quantity of water delivered in a given time is an important element in the experimental data, it may be well to show here how closely the results from the mean of all the experiments made with a given head and form of gate, agree with the calculations from the experiments giving the ratio, and which are alluded to above. For this purpose it will be sufficient to give an abstract of the detailed tables, by which the discharges under different heads, and with gates *a*, *b*, and *c*, are compared with the theoretical discharges.

This is done in the following table; of which the first column contains the head; the second, the number of experiments from which the mean ratio is deduced; the third, the ratios of the observed discharge for gate *a*, to that calculated upon the head and aperture; the other columns contain data similar to those given in the second and third, but for gates *b* and *c*.

TABLE THIRTEENTH.

Mean ratio of practical and theoretical discharges through gates a, b, and c.

Head above gate.	Gate *a*.		Gate *b*.		Gate *c*.	
Feet.	Number of experiments used for mean.	Mean ratio, practical to theoretical discharge.	Number of experiments used for mean.	Mean ratio, practical to theoretical discharge.	Number of experiments used for mean.	Mean ratio, practical to theoretical discharge.
2.75	15	0.58	12	0.94	6	0.73
1.25	14	0.61	4	0.93	6	0.74
0.75			3	0.85	5	0.72
0.50	6	0.77	3	0.77	3	0.70
	Mean,	0.65	Mean,	0.87	Mean,	0.72

The striking accordance of these results with the former ones (viz: .63, .85, .72) is at once seen. In fact the detailed tables before referred to show a very satisfactory coincidence of ratio in the actual to the theoretical discharges, the circumstances being the same, thus proving that uniformity of aperture was insured, where it was attempted. We may confidently rely that a gate of the form *b*, will discharge thirty-four per cent. more water than *a*, and twenty per cent. more than *c*, under the same head and opening.

The velocities of the wheel obtained with these gates are in conformity with the conclusions already drawn. A comparison of the velocities under corresponding heads, from table fourth, shows for *a*, a velocity of 4.92 feet per second, for *c*, a velocity of 5.58 feet, and for *b*, a velocity of 5.84 feet, the proportion of the velocities being as 1.00 to 1.13 and 1.18.

It may be laid down, then, that *while the form of the gate does not influence the ratio of effect to power, it affects the velocity of the wheel.*

This variation may depend, in fact, upon the variation of quantity as already shown, but *must also depend upon the manner in which the water is delivered to the wheel by the gate*, as may be seen from the following table. In it a comparison is made between the variation in the velocity of the wheel produced by a variation of aperture, which of course changes the quantity, and the variation produced by the gates. As the head of water also changes the quantity but at the same time varies the velocity of the water, the results under different heads are presented separately in the first tabular view, and any effect from the heads is in a great degree eliminated in the second by the mode of taking the average.

TABLE FOURTEENTH.

Presenting the variation in the velocity of the wheel by a change of aperture, and by a change in the form of gate. Overshot No. I.

Effect of variation of aperture drawn from table twelfth.

Head.	Ratio under widths of aperture of	
	0.50	1.25
2.75	1.00	1.06
2.25	1.00	1.05
1.25	1.00	1.04

The same from table eleventh.

Width of aperture.	Ratio of vel. wheel.
0.50	1.00
0.75	1.01
1.00	1.12
1.25	1.08
1.50	1.12

Effect of change of gate in varying velocity.

Relative quantities discharged by the three gates.	Relative velocities of the wheel produced.
1.00	1.00
1.14	1.13
1.35	1.18

It is plain from this examination that while an opening will soon

be reached which will give the maximum velocity, and the change in this element becomes inconsiderable, the form of gate is of great importance in practice, in consequence of the mode in which the water is delivered by it to the wheel.

The third question to be examined under the general head 2, (page 150) is the proper velocity to be given to the periphery of an overshot wheel. It is one of the points of our subject which has been much discussed. Smeaton at first assigned three feet per second as the proper velocity for the periphery of the wheel, afterwards adopted eight and a half feet, and Oliver Evans deduced nine feet per second as the result of his experience. The experiments of the Committee show that within the limits where the diminished action of the weight of the water upon the wheel, by an increase in the head, begins to diminish the effect, there is a considerable latitude as to velocity.

In wheel No. I, as will be seen by recurring to table sixth, between the lowest head which would fill the aperture (.50 foot,) and the highest which the experiments admitted, and where the ratios began sensibly to diminish (2.75 feet,) there is a diminution in the ratio of effect, of but two per cent; and between .50 and 1.25 feet, the diminution is scarcely sensible. The range of velocities between these limits is shown by table tenth to be, for

Gate *a*,	4.44	4.88	5.43
Gate *c*,	4.60	6.15	5.35
Gate *b*,	4.65	5.22	7.59*
And at a mean	4.56	5.42	6.12

The velocity of the wheel having been before proved to be connected with the velocity of the water falling into the buckets, we now see that *without diminishing the ratio of effect to power more than two per cent. we may so arrange a high overshot wheel as to increase the velocity of its periphery from four and a half to six and an eighth, and probably even to seven and a half feet per second.* It is thus easily understood that the proper velocity in a given case could not be detected by experience, but required experiment for its determination.

3. *The quantity of work* done in a given time depends, when the ratio of effect to power is the same, upon the velocity of the wheel. The remarks, therefore, which have been made upon the latter subject will serve as guides to determinations concerning the former.

4. *On the relative value of elbow and centre buckets in an overshot wheel.*—As has been previously stated, experiments were made

* On examining the table whence this number is taken, there does not appear evidence to question its correctness.

with wheel No. I, furnished with both elbow and centre buckets. It has been heretofore shown, table ninth, that the elbow buckets were of a proper figure; we now propose to compare the results of the two kinds of buckets in reference to the ratio of effect to power, and also in reference to the velocity of the wheel.

The following table is taken from tables C and D (vol. viii, pp. 89 and 147,) the first containing the experiments with the elbow, and the second with the centre buckets, gate *c* being used in each case. The velocities are those corresponding to equal apertures.

TABLE FIFTEENTH.

Comparison of the ratios of effect to power with elbow and centre buckets. Overshot No. I.

Head.	Elbow buckets table C.	Centre buckets table D.	Elbow buckets table C.	Centre buckets table D.	Aperture.
Feet.	Ratio.	Ratio.	Velocity.	Velocity.	Inches.
2.75	.814	.628	5.35	6.86	1.00
1.25	.841	.640	6.20	5.66	1.25
0.75	.841	.666	5.07	5.66	1.50
0.50	.831	.655	4.60	4.65	1.50
Mean	.832	.647	5.31	5.71	
Ratio	1.00	0.78	1.00	1.08	

The ratio of effect to power with the centre buckets, is but .78 of that with the elbow buckets. No doubt owing to the water sooner leaving the former than the latter, notwithstanding the assistance of the breast.

The velocity of the wheel appears to be greater in the second case than in the first. This is in part due to the increased quantity of water received into these buckets, as shown in table ninth, but perhaps more to the irregularity observable by comparing the results in the second or third column of the last table with themselves. The first velocity in the column for elbow buckets, appears to be too small, and the third in that for the centre buckets to be too great.

5. *On the use of air vents.*—It is doubtful whether there can be need of air vents in a properly constructed elbow bucket. The openings made in the soling for this purpose have been described in a former part of this report. The results of experiments made with these vents open and closed are annexed.

TABLE SIXTEENTH.

Experiments with air vents open or closed. Overshot No. I.

Head.	Width of aperture.	Elbow buckets table C.	Centre buckets table D.	Air vents.	Relative effect for elbow buckets.	Relative effect for centre buckets.
Feet.	Inches.	Ratio.	Ratio.			
2.75	1.00	.814	.634	Closed.	1.00	1.00
"	"	.809	.582	Open.	0.99	0.92

It appears that the air vents being open or closed made scarcely a sensible difference in the elbow buckets, and produced a loss, from the escape of water, in the centre buckets.

6. *On the results of an overshot wheel allowance being made for the loss of power by the head of water above the wheel.*—The overshot wheel, in practice, losing something in its effect by the head of water above the wheel, it will be useful to ascertain the allowance to be made for different heads, and also whether having made a correction for this, the difference between the effect and power is not greater than may be due to the water in part leaving the bucket before it reaches the bottom of the wheel, and in part being carried beyond the centre by the motion of the wheel.

The first of these questions cannot be settled by reference merely to wheel No. I, the heads being small in proportion to the fall, but for the same reason the second problem may be examined advantageously, and its results applied to the experiments with the other overshot wheels.

In this view the effect of an overshot wheel as practically used, is to be considered as composed of the impulse of the water and of its weight, or of an undershot and overshot. The undershot co-efficient, or ratio of effect to power, has not yet been obtained but may be considered for the present purpose as .284. The head through which this acts is composed of two parts, the head above the gate, and the distance from the gate to the bottom of the bucket of the wheel. As the water receives through the latter an acceleration due to the whole distance, a virtual head* must be found for it before adding it to the former. The sum being multiplied by the overshot co-efficient gives a number proportional to the whole effect of impulse.

The distance from the bottom of the bucket to the bottom of the wheel multiplied by the true overshot co-efficient gives its proportion-

* This for the mean of gates *a*, *b*, and *c*, will be the distance from the aperture to the soling, divided by $(.73)^2$, or by .533; or multiplied by 1.876.

al effect. The sum should be equal to the observed ratio of effect to power, multiplied by the head and fall.

The following table is calculated upon this principle, the quantity sought being what may be called the theoretical overshot co-efficient.

TABLE SEVENTEENTH.

Ratio of effect to power in a theoretical overshot wheel.

Head and fall.	Overshot co-efficient from table 6th.	Head above gate.	Virtual head of impulse.	Undershot co-efficient used.	Product of head and fall by overshot co-efficient.	Product of virtual head of impulse by undershot co-efficient	Difference of two products.	Fall below bottom of bucket.	Quotient, or theor. overshot co-efficient.
Feet.		Feet.	Feet.						
23.00	.828	2.74	4.06	.284	19.04	1.153	17.88	19.4	.921
21.50	.842	1.25	2.56	"	18.10	0.727	17.37	"	.895
20.75	.845	0.50	1.81	"	17.74	0.514	17.23	"	.888
								Mean	.901

The effect thus appears at a mean to be nearly nine tenths of the gravity of the water. This result would be accounted for if the water leave the wheel at an average of two feet above the bottom.

If now we assume the average co-efficient .900 for the effect of the theoretical overshot we shall find the co-efficients for the different heads and falls as follows:

For	23.00	feet	.811
"	21.50	"	.848
"	21.00	"	.858

being in defect and excess of the actual ratios at the two extremes, between one and two per cent. The small variation of the head and fall, however, as has been before remarked, renders the coincidence of this result a test of comparatively little value.

[TO BE CONTINUED.]

On Indigo. Part II. *By* J. C. BOOTH.

CONTINUED FROM PAGE 164.

The chemical relations of Indigo-blue.—The blue substance contained in the indigo of commerce, being the only one of importance in colouring operations, its singular and unique action with many of the chemical agents, next demands our attention. According to the method of preparing the pure blue colour, described in the preceding part of the essay, it will be observed that a protosalt of iron was precipitated by lime, the protoxide becoming peroxide, while the blue colour of the indigo disappeared, as it united with the

lime. Here, then, according to the most commonly received theory, the indigo-blue has been deoxidized, and combines with the lime, after the nature of an acid. This important change first requires attention.

1. *Reduction of Indigo-blue.*—The deoxidation may be effected by any substances which have a strong affinity for oxygen, such as phosphorus, the sulphurets of potassium, calcium, antimony, and many sulpho-salts, particularly the sulf-arsenites, by protosalts of tin, iron and manganese, farther by filings of zinc, iron, tin, &c. Even organic materials, in the process of fermentation, have a similar action. The presence of a free alkali or alkaline earth is essential to the change, and seems to act by its presence or catalytic influence, as metallic zinc decomposes water by the presence of sulphuric acid, which unites with the newly formed oxide; for none of the above named substances will deoxidize indigo unless an alkaline base be present to combine with it when reduced. Thus in the process described in Part I, the reduced indigo combines with the lime forming a soluble compound, while the iron is peroxidized at the expense of the oxygen of the indigo-blue and precipitates. After the solution of the calcareous compound has become perfectly clear, it is drawn off by a syphon into another flask, so as to fill it even to overflowing, by which a small portion of the blue, which has reformed, may be carried off. A few drops of concentrated sulphuric or acetic acid previously deprived of air by boiling or in vacuo, are now added, and the flask closed by a well ground stopper, whereupon an abundant white and flocculent precipitate appears which slowly collects at the bottom of the vessel. This is reduced or deoxidized indigo. The clear liquor is drawn off, and the precipitate, placed on a filter, is washed with well boiled water, (during which operation it gradually becomes grayish green,) then dried between paper and in vacuo, or even in the air at a very moderate temperature, 75° Fahrenheit. The greenish shade it assumes appears to be an intermediate state of oxidation between the white and blue. Reduced indigo is white, somewhat crystalline; has neither taste nor smell, does not redden litmus paper, and is insoluble in water. It dissolves in alcohol and ether, with a yellowish colour, from which it separates as indigo-blue, either by exposure to air or boiling down. In a moistened state, it becomes deep purple in a few hours, in dry air, it changes to blue, only after several days. So strong is its attraction for oxygen, that it cannot be kept even in closely stoppered bottles. By heating the dry mass cautiously in the open air, when the temperature rises to a certain point, it suddenly becomes dark and purple coloured; a phenomenon resembling the sudden oxidation of a metal. By a higher heat it rises as a pur-

ple gas. It appears to have no affinity towards dilute acids, but dissolves instantly in concentrated sulphuric acid, with a deep purple colour. The nature of this solution is unknown; but may it not arise from a reduction of a portion of sulphuric to hyposulphuric acid, which combines with the newly formed indigo-blue? It combines forcibly with strong bases, being dissolved by carbonated and caustic alkalies, and by caustic baryta, strontia and lime, with a yellow colour.

The combinations of reduced indigo with the bases cannot be obtained pure in a dry state, for even under the air-pump they change so far as to conceal their characters. Lime forms two combinations; the one exactly saturated with the indigo is soluble in water, the other with an excess of lime, insoluble, and of a citron yellow colour. Magnesia likewise forms a compound somewhat less soluble. Other compounds may be obtained by introducing a crystalized salt into a saturated solution of reduced indigo. Salts of alumina, protoxides of iron and tin, and oxide of lead, precipitate white compounds, which become instantly blue in the air; oxide of cobalt and protoxide of manganese, form green, and oxide of silver, brown and black precipitates.

It appears, then, that reduced indigo, although presenting no acid character in itself, combines with bases after the manner of an acid, forming both soluble and insoluble compounds; that its attraction for oxygen is powerful, becoming converted thereby into indigo-blue, which is an unusually indifferent substance.

When indigo is obtained from plants, it does not exist in the juice of the plant as such, but is formed after its expression, and by contact of the air. It is therefore highly probable that it is contained in it as reduced indigo, but as the latter is insoluble in acids, and requires the presence of a base, while the infusion of indigo plants always reddens litmus, it remains to be determined, by future experiments and observations, in what state it exists in the juice of the plants.

2. *Soluble Indigo-blue.*—Sulphuric acid has a peculiar decomposing action on various organic substances, combining with a portion of the generated products, and although retaining its acid character, ceases to exhibit the properties of sulphuric acid; for the body combined with the acid cannot be separated from it by bases, but enters into the composition of its salts, which are very different from sulphates. Indigo-blue is one of these substances, and exhibits properties, the theoretic nature of which remains a mystery.

When Indigo-blue, purified from the brown, red, &c., as described in Part I, is treated with fuming sulphuric acid, it combines with it rapidly, evolving heat, and no sulphurous acid; even dry sulphuric

acid produces the same result. Dilute acid has no action, and the stronger the acid, the more colouring material is dissolved. Thus while six parts of the fuming acid are requisite for the solution, twelve parts of strong oil of vitriol are required, and then usually with the assistance of a temperature not higher than 212° Fahrenheit. Such a solution communicates a distinct blue colour to 500,000 times as much water. As the exact nature of the combinations is not understood, we shall follow the ordinary nomenclature, and call the two acid compounds resulting from the solution, ceruleo-sulphuric and ceruleo-hyposulphuric acids; a third compound also results, called indigo-purple, or phenicine, but as it is unimportant, the mention of it may be sufficient. The more fuming the acid, the more blue hyposulphuric is formed, and the less residue of indigo-purple, while strong oil of vitriol produces more of the blue sulphuric, and frequently leaves a large portion of purple.

These acids may be prepared by digesting the pure indigo-blue in a dry state, in twelve parts of very concentrated sulphuric acid, adding the powdered colour little by little to the acid, and suffering the mixture to stand twenty-four or forty-eight hours, according to the temperature, which should not be above 212°; it is then diluted with thirty to fifty times its bulk of water, and filtered. What remains on the filter is indigo-purple. Wool or flannel, thoroughly cleansed by soap, a very dilute solution of carbonate of soda (1 to 100) and water, is immersed and digested in the liquid at a moderate warmth, by which the blue acids are extracted, and colour the wool of a deep blue. When all the colour is thus taken up, the wool is thoroughly washed with water, pressed, and put into a very dilute solution of carbonate of ammonia, whereupon the acids leave the wool and combine with the ammonia. This solution is evaporated to dryness at 140°, and treated with alcohol of 0.833, which dissolves the ceruleo-hyposulphate of ammonia, and leaves the blue sulphate undissolved.

Ceruleo-sulphuric acid is obtained by dissolving the last named salt in water, and precipitating with acetate of lead, which throws down ceruleo-sulphate of lead. By stirring this salt with water, and passing sulphuretted hydrogen through it, sulphuret of lead is precipitated while the reduced blue remains in the yellowish liquid. It is deoxidized blue in combination with sulphuric acid, which, by exposure to the air, becomes the ceruleo-sulphuric acid. The blue hyposulphuric acid is obtained by precipitating the above alcoholic solution of the ammoniacal salt by a solution of acetate of lead in alcohol, and then proceeding as for the sulphuric acid. In either, the sulphuretted hydrogen should be removed, and the liquid should not be filtered until it is perfectly blue.

The blue acids have a powerful affinity for bases, and the resulting compounds, are not to be regarded as double salts, for in the ceruleo-sulphate of baryta, the sulphuric acid exactly saturates the baryta, so that the blue colour appears to combine with the salt, somewhat like water of crystalization in ordinary salts. It will appear from this that it still remains for the chemist to determine in what manner the blue colour combines with the acids. These ceruleo-salts have all a fine blue colour, whether soluble or otherwise, taste slightly saline, and very strongly like indigo, and require a considerable amount of heat to decompose their organic colour. The sulphates of the alkalies are scarcely soluble in alcohol of 0.84, and are precipitable by colourless alkaline sulphates, and even by other salts. The corresponding hyposulphates are soluble in alcohol, and scarcely precipitated by other salts. Both series of salts, when soluble in water, leave by evaporation to dryness, an uncrystalized mass, with a cupreous metaliic lustre, surpassing that of insoluble indigo-blue. The ceruleo-salts of potassa, soda and ammonia, may be prepared pure by digesting the blue wool, alluded to above, in the carbonates of those alkalies to saturation, evaporating to dryness, and treating with alcohol, which dissolves the blue hyposulphates, and leaves the ceruleo-sulphates. The corresponding compounds of lime and magnesia are prepared, as those of the alkalies may also be, by treating the solution of indigo-blue in sulphuric acid by their carbonates, and by farther separating the two series from each other by alcohol. The salts of baryta and lead may be precipitated from the soluble alkaline compounds, by solutions of those metals.

The blue colour in the two acids is susceptible of a deoxidation similar to insoluble indigo-blue. If filings of zinc or iron be placed in their solution, the metals are oxidized at the expense of the blue colour, for hydrogen is not evolved, and with an excess of acid the solution is colourless or yellowish, but instantly becomes blue by contact with oxygen or atmospheric air. It is the most delicate of all tests for the presence of oxygen gas. The blue colour is more easily reduced in the salts than in the acids, and most readily when there is an excess of base. A beautiful experiment illustrates this property. Protosulphate of iron may be dissolved in a neutral blue solution, and heated in it without inducing reduction; even a large portion of protoxide of iron may be precipitated with alkali without producing a change; but the moment we add an excess of alkali, the blue fluid instantly changes to yellow. By saturating the solution with acid, it soon becomes blue, and may again be rendered yellow by a new excess of alkali. It is remarkable that indigo-blue should suffer its

peculiar deoxidation, but more so that this soluble blue should resemble it in this feature, although differing in most others.

The blue colour is not so firmly united to the two acids of sulphur as not to form other compounds; thus by mingling chloride of calcium with a blue solution, and adding phosphate of soda, a fine blue phosphate of lime precipitates; if carbonated alkali be added, a less brilliant ceruleo-carbonate of lime is thrown down. Even tannate of oxide of lead may be obtained as a blue precipitate, by throwing acetate of lead and tannin simultaneously into the solution. It would be highly desirable to multiply experiments of such a character, as the transposition of the blue colour may yet prove of service in dyeing and printing operations.

Soluble indigo-blue is as fugitive as many vegetable sap colours, suffering alteration from the solar ray, heat, nitric acid, caustic alkalies, &c., forming new bodies which unite with the sulphuric and hyposulphuric acids, and give rise to new acids. If ceruleo-hyposulphate of baryta be evaporated to dryness in a water bath, it becomes green, and contains *virido-sulphuric acid*, which may be obtained like the blue sulphuric. If one part of ceruleo-sulphate of potassa be dissolved in fifty parts of lime-water, and heated in a closed vessel, for several hours, the solution becomes of a purplish red colour; by filtering, and passing carbonic acid through the solution, evaporating to dryness, and treating with alcohol, a small portion is dissolved with a red colour. The insoluble residue dissolves in water with a dark purple-red hue, and being precipitated by neutral acetate of lead, gives a salt containing a new acid, the *purpuro-sulphuric*. If the blue sulphate of potassa be similarly treated, in an open vessel, with lime water, the colour of the solution graduates through green, purple, and red, into yellow; but by ceasing when it is red, precipitating by carbonic acid, and evaporating to dryness, alcohol extracts a yellow compound, while the residue becomes red. Sugar of lead throws down from the tincture a citron yellow salt, containing *flavo-sulphuric acid*, while the remaining fluid is red. The red residue insoluble in alcohol, and the last red solution contains a reddish acid, which, by solution in absolute alcohol, yields *fulvo-sulphuric acid* of a reddish-yellow tint; and the residue insoluble in absolute alcohol, gives a fine red solution with water, containing the *rufo-sulphuric acid*. A cursory view of this subject might lead to the supposition that these singular, varied, and beautiful compounds, although interesting to the chemist, can never be rendered available in practical operations; but we have already too many instances in the arts of substances now employing the hands of numerous artisans, which only sprang into existence under the touch of the chemist, to listen

to such assertions. When the existence of chrome was first made known to the world, who could have imagined that it was destined to play an important part in the arts; or even when sand and alkali first fused together, by an accidental intensity of heat, who could have known that the resulting glass would eventually prove a source of many of the comforts and conveniences of mankind? Neither can we now assert that an intimate knowledge of the varied and curious properties of indigo arising from the labours of the chemist, can prove of no benefit to manufactures.

3. *Action of nitric acid on Indigo.*—This acid has a peculiar decomposing action on a variety of organic substances, giving rise to a host of new products, which are not yet well understood. Thus by its action on indigo, it produces several distinct acids, of which but little is known, not so much from a want of extended observation and experiment, as from the extreme difficulty attending such chemical investigations. If we employ nitric acid, of 1.28 sp. gr., diluted with an equal bulk of water, and add to it one part of finely powdered indigo, as fast as it is decomposed, with the assistance of warmth, two acids form in the solution, and by concentration, precipitate together in a crystalline form. By solution in boiling water, and cooling, fine needles separate, which are *nitroanilic acid*, formerly called indigotic acid. It may be purified and separated from the *nitropicric acid*, which is also formed, by boiling its solution with freshly precipitated carbonate of lead, when the nitroanilate of lead remains in solution. When purified, the acid crystalizes in fine white needles, of a strong acid taste. It combines with the alkalies, earths, and many metallic oxides, forming yellowish or reddish compounds.

The nitropicric acid may be formed more readily by digesting one part of indigo with 8 to 10 parts of moderately strong nitric acid, with the assistance of a gentle heat, and as soon as the liquid ceases to evince decomposition, and is still, by heating it to boiling, and adding, from time to time, nitric acid, as long as nitric oxide is evolved. The fluid, suffered to cool, deposites crystals of the acid, frequently called the carbazotic, and formerly Welter's Bitter. It combines with bases, usually forming yellow salts. The salt, with potassa, being rather insoluble in water, and wholly so in alcohol, this acid has been employed to detect the presence of potassa. It has also been recommended by Braconnot as a remedy for intermittent fevers. Excepting these, the salts of these two acids have received no practical application. In regard to the manner in which their elements are combined, it is difficult to hazard a conjecture: but Berzelius rather regards them as organic bases combined with nitric acid. Thus the nitroanilic acid may be represented as $(C^{14}\ H^{8}\ O^{4}) + NO^{5}$; and the

nitropicric as composed of $(C^{12}\ H^4\ N^2\ O^3)\ NO^5 + (HO)\ NO^5$; and when the latter combines with a base, as potassa, the HO, or atom of water, is replaced by that base; thus $(C^{12}\ H^4\ N^2\ O^3)\ NO^5 + (KO)\ NO^5$. It is probable that much time will not elapse ere these dark regions in organic chemistry will be illuminated by advancing science. They have been presented, as well to give a complete and yet condensed view of the subject of this essay, as to point out the numberless modifications of which a single substance is susceptible. In the succeeding part of the essay, we shall devote a few pages to the practical operations connected with indigo.

[TO BE CONTINUED.]

Report to the Trustees of the Philadelphia Gas Works, on the progress and state of the Works, January 22, 1841. *By* J. C. CRESSON, *Superintendent.*

In compliance with the request of the Board, the Superintendent has the honour to present a brief history of the works from their commencement, and a view of their present operations and capacity.

Ground was broken on the site selected for the location of the works, in the month of April, 1835, about one month after the final passage of the ordinance of Councils authorizing their construction.

The erection of the buildings and apparatus, and the laying down of the main pipes in the streets, were prosecuted with the characteristic energy of the engineer, Samuel V. Merrick, Esq., and they were so far completed as to be in readiness for the manufacture and reception of gas on the 8th of February, 1836, less than ten months from their commencement; and on the 10th of February, the gasometer and mains were filled, and gas furnished for public and private lighting. The works then completed, consisted of a retort-house, 98 by 48 feet, capable of accommodating thirty retorts, and storage for 12,000 bushels of coals; a purifying and lime house, 40 by 20 feet, containing one set of dry lime purifiers; a set of vertical condensing pipes, placed on the north side of the purifying house, above ground, presenting a surface for deposite of 600 square feet; a range of buildings, 133 by 20 feet, containing office, meter room, laboratory, and workshop; and two gasometers, fifty feet in diameter, with a capacity of 35,000 cubic feet each, in tanks of masonry, entirely under ground.

The street mains laid, comprised 9140 feet of ten inch pipe, partly in Filbert, and partly in High streets, extending from the works to Delaware Second street; pipes of two, three, and six inches diameter, in some of the lateral streets, chiefly Second, Third, and Fifth streets, and four and six inch pipes in Chesnut and High streets, to the extent of 4018 feet of six inch, 9430 feet of four inch, 12,400 feet of three inch, 2310 feet of two inch, and 1354 feet of branches, making a total

of 38,652 feet, or seven and one third miles. On this extensive line of mains, only nineteen private and forty-six public lights were ready to receive gas when the works were first in a condition to furnish it. This paucity of consumers resulted, not from any indifference on the part of the public, but from the tardiness with which the few persons engaged in the business of putting up gas fittings completed their work. The usual laws of supply and demand soon called into the business many of our enterprizing mechanics, who, by their activity, were able to keep pace with the increasing calls for the means of lighting with gas; and by the close of the year it was supplied to 2800 private, and 165 public lights, consuming daily about 42,000 cubic feet. The maximum daily consumption in the first year, was 48,500 cubic feet, and the whole quantity made in 10½ months, 6,481,300 cubic feet. The progress of the demand is shown in the second column of the accompanying table, marked A.

In the course of this year, a small addition was made to the street mains of 2951 feet of three inch pipes.

At the close of 1836, authority was granted by Councils to extend the works, by means of a loan of $ 150,000; on condition, that before any dividend to the Stockholders should be declared, the sum of eight per centum on the amount borrowed for the extension of the works, should be annually set apart and reserved from the nett profits, to be applied, first to the payment of the interest on said loan, and the balance to be invested as a sinking fund for its redemption, in case the Stockholders should be allowed to retain possession of the works until the loan reached maturity; which was to be in twenty-five years. The said sinking fund, and its accumulations, to revert to the Stockholders, if Councils should take possession of the works prior to the twenty-five years, which they have the power to do at any time they may see fit. Measures were promptly taken by the Trustees to give to the public the benefit of this addition to the means at their disposal. The works were originally laid out on a plan which would admit of symmetrical enlargement, without interference with the parts already constructed; by the erection of additional sections, corresponding in exterior to the first, but entirely independent and complete in the interior arrangement and apparatus.

The first step in this system of enlargement was undertaken in the year 1837.

The retort-house was extended to nearly double its original length, and by the adoption of a different arrangement of the interior, was made capable of receiving sixty additional retorts, and furnishing store room for 25,000 bushels of coal. The bench for thirty retorts was completed at once, and the second section, thus formed, was pro-

vided with purifying and condensing apparatus, by converting the lime house into a purifying house, and fitting up therein a second set of purifiers, with a series of condensing pipes and drips against its northern flank. A range of sheds, supported on cast-iron columns, was erected against the walls which enclosed the yard, which furnished store room for 100,000 bushels of coal and coke.

Two additional gasometers, with their tanks, similar in their dimensions to those in use, were constructed; and the part of the lot thus filled up, was enclosed with a substantial brick wall.

In a word, the productive capacity of the works was doubled, and accommodations provided in part, for another section, whenever it should become necessary, and a storage of an ample supply of coals provided under cover. As the consumption of lime for purification had increased sufficiently to make it an object to produce it on the premises, a small perpetual kiln, for calcining shells, was put up, and the whole supply of lime economically obtained, by burning oyster shells with the refuse breeze from the coke. The extension of main pipes in the streets was made to keep pace with the enlargement of the works; the additions were as follows: ten inch, eighteen feet; six inch, 6984 feet; four inch, 4302 feet; three inch, 13,068 feet; two inch, 3468 feet; in all, 27,840 feet, or five and one quarter miles, making an aggregate of thirteen miles of street mains. The number of lights supplied at the close of the year, had increased to 6814 private, and 300 public lamps. The maximum daily consumption in the year was 105,500 cubic feet, and the whole quantity of gas produced in the year, 17,078,000 cubic feet, making a total production of 23,560,000 cubic feet.

Two dividends, of four per cent. each, were paid to the Stockholders this year, one of the profits earned to the first of January, in the first ten months operations, and the other, of those earned in the six months, ending the first of July.

The rapid increase in the demand for gas having more than doubled the daily consumption, and the growth being as yet unabated, with every prospect of its longer continuance, it became necessary to look to some provision of additional leading mains for the supply of the remote eastern sections of the city, and an extension of gas store room at the works. To meet these contingencies, a second application was made to Councils for authority to raise the requisite funds, by loan, and this was granted, to the amount of $200,000, upon the same conditions as were imposed on the first loan. In accordance with the system marked out, when the plan of the works was originally adopted, a sixteen inch main was carried south from the works, along Ashton street to Spruce, a distance of 2340 feet; and from this a

twelve inch main was laid down Spruce street, from Ashton street to the Delaware, 10,881 feet. The Spruce street main was laid as far as Ninth street, a distance of 8000 feet, without any branches for lateral connexions; being designed to insure a full supply to the eastern parts of the city.

From the twelve inch main, six inch pipes were branched at Ninth, Sixth, and Second streets, to connect and complete the circulation between the two great mains on the northern and southern routes; the connexions at Sixth and Second streets were completed, and the six inch mains extended to the northern boundary of the city, at Vine street. Numerous smaller mains of two, three, and four inches diameter, were laid in different parts of the town, to accommodate the applications for gas, which continued throughout the year with scarcely any abatement in number and frequency.

The extent of mains, of various sizes, laid in 1838, was sixteen inch, 2340 feet; twelve inch, 10,881 feet; ten inch, 27 feet; six inch, 9036 feet; four inch, 14,409 feet; three inch, 15,660 feet; two inch, 150 feet; total, 52,503 feet, or nearly ten miles, which, added to those previously laid, made the whole extent of street mains twenty-three miles.

The increase in the consumption of gas continued during this year in the same remarkable ratio as in the preceding, the number of customers, and the amount of gas sold being more than doubled. The maximum daily consumption was 180,000 cubic feet, and the whole quantity made in the year, 27,357,000 cubic feet; the number of private lights, at its close, was 11,102; of public lamps, 434. Two dividends, of six per cent. each, were paid to the Stockholders, out of the profits earned, to the first of January and July of this year, and the semi-annual dividends since then have been of the same amount. The unparalleled augmentation of the demand for gas, which had hitherto been experienced, had made it necessary to continue an almost uninterrupted series of extensions of the capacities of the works, and pipes of conduit; on one occasion it was deemed most prudent to close the book for applications, lest they should increase too rapidly for the means of supply. But the establishment had now attained a magnitude which rendered it probable that the same rate of increase could not be maintained for a much longer time; and yet the additions to the number of consumers were on the increase during the greater part of the year just closed, and thus far showed no symptoms of abatement. Under these circumstances, it became a matter of no little difficulty to determine the proper rate for future extensions, so as, on the one hand, to keep pace with the wants of the public, and on the other, to avoid the unnecessary loss of interest from premature

expenditure of funds. The buildings and apparatus for the manufacture of gas, are of such a character as to require considerable preparation, and months of labour for their proper construction; and the measures to be adopted must therefore be predicated, not upon the present condition of the business, but upon its prospective condition some ten or twelve months in advance.

Upon deliberate consideration of the whole ground, it was thought most prudent to make another addition to the works in 1839, although at the close of the preceding year they were capable of furnishing some 40,000 or 50,000 feet more per day than the average demand.

Accordingly, the bench for thirty retorts, in the third section of the retort-house, was fitted up, and an addition was built to the purifying house, and furnished with the requisite purifiers, condensers, &c., to complete a third series of works, equal in capacity to each of the other two. Four additional tanks were likewise constructed, with gasometers corresponding to the four already in use; and a store cellar built alongside of the retort-house, with room for 60,000 bushels of coals. The quantity of gas produced by each section of the retort-house having been increased considerably beyond what they were originally estimated to be capable of generating; it was found that the purifying apparatus, as first arranged, was insufficient to render the gas as pure as it ought to be, and it became necessary to devise some means of adding to its efficiency, without throwing out of use the extensive fixtures which had already been constructed. This was effected by adding a second story to the purifying house, and placing on the upper floor duplicate sets of purifiers, connected collaterally with those below; which gave a double extent of purifying surface, and passed the gas at a reduced pressure, sufficiently purified, without any departure from the ground plan already adopted.

For the more perfect separation of ammoniacal deposits, which sometimes prove a source of much annoyance to the gas manufacturer, a set of large refrigerating cylinders was put up between the retort-house and condensers; these are supplied with jets of water, throwing into each cylinder about two gallons an hour; and since they have been in operation, in conjunction with the double sets of purifiers, the gas passes from the works free from any appreciable noxious impurity, even when subjected to the nicest tests of the laboratory. The means of distribution likewise received considerable additions this year; the mains laid, were eight inch, 3726 feet; six inch, 4419 feet; four inch, 11,997 feet; three inch, 11,629 feet; and two inch, 1704 feet; in all, 33,475 feet, or about six and one quarter miles, making an aggregate of 29⅗ miles. The maximum consump-

tion was 207,000 cubic feet, and the whole quantity of gas made, was 39,473,000 cubic feet.

The number of lights supplied at the close of the year, 15,851 private, and 596 public.

A comparison of the operations of the works for the year 1839, with those of the previous year, shows that the ratio of increase of demand had very much fallen off, being less than fifty instead of one hundred per cent., as in former years; this may be taken as an indication that the boundaries of the profitable districts had been passed, and that future extensions would tend rather to diminish than to increase the profits of the concern. This impression has been confirmed by the experience of the next succeeding year, which has just elapsed; the increase of demand for gas being again, not only in a very much diminished ratio, but the actual excess only about one half that of the preceding year.

During the year 1840, the improvement at the works have been limited to the completion of the improved plan of the retort-house, by taking down the retort-bench of the old section, and remodeling it so as to make room for a double bench, with coal stores below, as in the section last built; a change which it was necessary to make, while the summer demand was within the capacity of one double bench with sixty retorts. The pipes laid have been only a few small sections to complete connexions, or supply applicants near the terminations of the lines.

They comprise, six inch, 261 feet; four inch, 576 feet; three inch, 1674 feet; and two inch 222 feet; in all 2733 feet; making the total length of mains 158,136 feet, or nearly thirty miles.

The maximum daily consumption of gas was 249,000 cubic feet, and whole quantity made in the year, 45,210,000 cubic feet, the number of lights increased to 19,799 private and 708 public.

These details have brought our history down to the present period; and it remains to give a connected view of the result of the transactions narrated, by a general sketch of the existing condition and capacity of the establishment.

The retort-house is a brick building, 195 feet long, 48 feet wide, and 18 feet high; covered with a roof composed entirely of iron; with an arched brick floor, resting on cast iron girders. The retort-benches are in two double ranges, placed back to back, with one horizontal flue, common to each double range; the two flues terminating in a single stack, 100 feet high, standing in the centre of the building. The whole will contain 120 retorts. The retorts are D shaped, seven feet long, two feet wide, and one foot high; and work off four hour charges of 150 pounds of coal; producing about 4,000 feet of gas in

twenty-four hours; they are set three to a fire. The standing pipes and dip-pipes are four inches diameter; the hydraulic main fourteen inches; and the general connecting pipes six inches. The gas is washed as soon as it leaves the hydraulic main; and passes from the washers to the refrigerators, which are upright cylinders, on square bases, eighteen feet high and forty inches diameter; four of these constitute a set, and are connected, so that two are collateral, and two consecutive; the connexion being through a double valve, by which one pair may be thrown out for cleaning or repair, without stopping the works.

From the refrigerators, the gas passes to the condensers, composed of a series of twenty upright pipes, eighteen feet high, and six inches diameter; standing upon drip boxes, which are drained by a connected series of syphons. The refrigerators stand on the south side of the purifying house, exposed to the weather; and the condensers on the north side, enclosed by a verandah with revolving venitian blinds, which are kept closed when the weather is severely cold. The purifiers are rectangular cast iron boxes, four feet square, and two and a half feet deep, with sheet iron caps, secured by a water lute. Three layers of lime, about three inches thick each, are placed on wicker bottoms, in each box;—eight of these boxes form one set; four being on the lower, and four on the upper floor of the building: the two boxes in the same vertical line are connected collaterally, and the gas passes through three double boxes in succession; the fourth being thrown out for the renewal of the lime: a single hydraulic valve forms the connexion for the eight boxes of one set.

Three sets of purifiers are completed, and the building is fitted for the reception of a fourth; its dimensions are eighty-five feet in length, twenty feet in width, and twenty-two feet in height, with a cellar under the whole, in which are placed the drips and syphons for the purifiers and refrigerator valves.

The range of buildings, comprising offices, workshops, and meter room, has received no exterior addition since its first erection; being as before stated, 133 feet long and 20 feet wide, constituting the front of the works on Ashton street; but two new station meters, of sufficient size to pass 10,000 feet per hour, have been placed in the meter room, and connected with the new sections of the works, so that the gas generated in each section, is separately measured; provision is made, however, for connecting either of the meters with all the sections, if necessary; and a similar precaution has been adopted in other parts of the works, so that if the condensers, purifiers, or meter of either section should need to be thrown out for inspection or repair; the gas generated in that retort-house can be passed through the apparatus of the others. The gasometers are now eight in number, with an aggre-

gate capacity of 280,000 cubic feet, and are so connected, as to work through either a single outlet of ten inches diameter, or through two independent outlets of the same size. The suspension is by three points; the chains converging to a single point, and connected to the counterweight by a cross bar.

The pulleys are supported on a triangular trussed bridging, sustained on cast iron stands eighteen feet high.

The works now completed occupy one half of the plot appropriated to their use, and are so arranged as to unite symmetrically with a similar series, to be constructed when needed, on the other half. The entire dimensions of the site are 306 feet, north and south, by 738 feet, east and west; intersected by Ashton and Beech streets, each fifty feet in width; it is bounded on three sides by public streets, and on the fourth by the Schuylkill river. One of the intersecting streets separates the gasometer yard from the offices and factory, and the other passes between the factory and the wharf front on the river. The space between Beech street and the river, is now used for the deposit of foul lime, and of shells from which the lime is made; the lime-kiln being on a portion of it: at a future day it will furnish valuable store-room for coals.

The present capacity of the works is sufficient to supply 300,000 to 350,000 cubic feet daily, with storage for 280,000 feet of gas, and 200,000 bushels of coals.

When the fourth section is completed, all the buildings for which are now provided, the productive capacity will be about 450,000 cubic feet per day.

The system of street mains consists of a sixteen inch main in Ashton street, from the works to Spruce, a distance of 2,340 feet; which is to head all the east and west mains; a twelve inch, down Spruce from Ashton street to the Delaware, 10,881 feet; a ten inch, from Ashton, down Filbert to Ninth, and along Ninth to High, and down High to Delaware Second street, 9,167 feet; these two mains being intended for the supply of the eastern part of the city, have no lateral connexions, except for services, until they reach Ninth street. There is also a main along High street from Ashton to Delaware Front street, consisting of eight, six and four inch pipes, about 10,000 feet in length; a six inch main in Chesnut, from Ashton to Ninth, and thence continued to Second, four inch, 9,500 feet; a four inch in Mulberry, from Delaware Front, to 150 feet west of Broad street, 6,000 feet; a four inch in Sassafras, from Delaware Second to Broad, about 5,300 feet; a four inch in Walnut street, from Dock to Schuylkill Seventh, about 6,000 feet; a four and an eight inch in Ceder street, from Delaware Second to Fourth, about 1,000 feet each.

Besides these leading east and west mains, several small sections have been laid in different streets to supply applications for light.

The lateral connexions embrace a three inch in Front, from Mulberry to High; a six inch on the east, and a three inch on the west side of Delaware Second, extending the whole breadth of the city from Vine to Cedar, each 5,370 feet in length; three inch on both sides of Third, from Vine to Spruce, except two small breaks, one on the west side, near Sassafras, and the other on the east side at Dock street; a three inch in Fouth street from Vine to Spruce, partly on both sides; a three inch in Fifth steet, from Sassafras to Spruce, partly on both sides, but with several breaks of continuity on both; a six inch in Sixth street, from Vine to near Pine, and connected at Pine by about 200 feet of three inch. Several squares of three inch in Sixth street, in small sections; a three inch in Seventh street, from Mulberry to Walnut; three inch in Eighth, from Cherry to south of Walnut, and from Locust to Spruce; a six inch in Ninth street from Sassafras to Locust, on the west side, and about 500 feet of three inch on the east side; several sections of three inch in Tenth, Eleventh, and Twelfth streets; a three inch in Thirteenth street, from St. John's Church, near High street, to St. Luke's below Spruce; a six inch in Broad street from Walnut to Pine, and about 200 feet of six inch south of Chesnut, both on west side; and sundry connexions of two and three inch pipes in the smaller streets and alleys. Comprising in the whole extent, of sixteen inch 2,340 feet, twelve inch 10,881 feet, ten inch 9,167 feet, eight inch 3,726 feet, six inch 24,718 feet, four inch 41,468 feet, three inch 57,982 feet, and two inch 7,854 feet—total, 158,136 feet, or within 264 feet of thirty miles.

The number of lights on these lines of mains, at the close of 1840, was, private 19,799; public, in streets 708, market houses 19, public squares, lighted only in summer, 62: making an aggregate of 20,588 lights in operation.

The whole cost of the establishment has been as follows:—

For Works on Schuylkill, - -	$237,903 28
For Street Mains, - - - -	168,957 22
For Services, - - - - -	56,135 95
For Public Lamps, - - - -	9,640 75
Total permanent investment,	$472,637 20

There is the sum of about $6000 outstanding, on account of permanent improvements, but as the stock of materials on hand is sufficient to liquidate the whole of this, it will not produce any material change in the amount above stated as the cost of the present series of Works, and means of distribution.

Annexed, are tabular statements giving a condensed view of the progressive condition of the several principal departments for each year since the commencement of operations. In statement A, is shown the length and size of main pipes laid in the streets; in B, the number of service pipes and meters set for customers; in C, the number of public and private lights in operation; in D, the quantity of gas made in each month; and in E, the sales of gas as registered by small meters. Each private customer is furnished with a meter, placed in his premises at the expense of the Company, and his bill made out from its indications. Similar meters are placed at several of the street lamps, in different parts of the city, and their average taken as the average of the whole number of lamps.

A comparison of D and E, shows the amount of loss from leakage and waste. The large proportionate loss in the first year was caused by the filling and proof of the gasometers, and blowing out the air from the street mains, when first brought into use: and that which has since occurred, is principally due to the opening of the mains for connexions, or attachments of service pipes. When these operations have been temporarily suspended, the loss has fallen below two per cent.; a fact which proves the almost perfect tightness of the extensive line of mains with its numerous joints.

[A.]—*Length of pipe, in feet, laid each year.*

Years.	2 inch.	3 inch.	4 inch.	6 inch.	8 inch.	10 inch	12 inch.	16 inch	Total.
1835	2310	13,000	10,184	4,018		9140			38,652
1836		2,951							2,951
1837	3468	13,068	4,302	6,984					27,822
1838	150	15,660	14,409	9,036		27	10,881	2340	52503
1839	1704	11,629	11,997	4,419	3726				33,475
1840	222	1,674	576	261					2,733
	7854	57,982	41,468	24,718	3726	9169	10,881	2340	158,136

[B.]—*Number and size of Meters set each year.*

Years.	3 light	5 light.	10 light.	20 light	30 light	45 light	60 light	100 light	Total.
1836	108	98	31	9	2	3			251
1837	301	77	19	6	2	3		3	411
1838	442	159	61	13	9	2	1	3	690
1839	421	118	75	26	6	3			649
1840	198	78	54	13	3	2		2	350
	1470	530	240	67	22	13	1	8	2351

[C.]—*Number of Lights added monthly.*

	1836.		1837.		1838.		1839.		1840.	
Months.	Public.	Private	Public.	Private	Public.	Private	Public.	Private	Public.	Private
January.				143		120	*18	511	*1	340
February,	46	529		235		185		559		338
March,		266		246		261		317		141
April,	34	515		253		207		446	6	221
May.	20	156		93	1	118		538	1	316
June,	22	139		55		192		400	7	112
July,	20	135		115		299	58	341	7	135
August,	20	193		760		378	33	389	4	193
Sept.,	3	241	36	402		333	14	533		704
October,		373	33	510	80	584	36	606	52	491
Nov.,		145	30	666	18	500		446	34	528
Dec.,		240	37	297	34	587	21	294	1	429
	165	2932	136	3775	133	3,764	180	5,380	113	3,948
			165	2932	301	6,707	434	10,471	614	15,851
			301	6707	434	10,471	614	15,851	†727	19,799

* In Market Houses.

† To these may be added sixty-two Lamps, placed in Franklin and Washington Squares in 1838.

[D.]—*Gas made at Works.*

	1836.	1837.	1838.	1839.	1840.
	Cubic feet.	Cubic feet.	Cubic feet.	Cubic feet.	Cubic feet.
January,		1,156,400	2,430,000	4,657,000	4,796,000
February,	205,200	1,006,200	1,980,000	3,437,000	4,082,000
March,	359,000	1,3 6,100	2,064,000	3,638,000	3,915,000
April,	362,300	1,104,400	1,918,000	2,862,000	3,362,000
May,	453,200	960,400	1,583,000	2,555,000	2,974,000
June,	361,600	866,400	1,471,000	2,058,000	2,454,000
July,	353,200	903,100	1,527,000	2,068,000	2,388,000
August,	442,300	1,078,100	1,669,000	2,301,000	2,506,000
September,	658,700	1,517,800	2,095,000	3,041,000	3,487,000
October,	921,200	2,119,700	2,857,000	3,801,000	4,444,000
November,	1,111,000	2,418,100	3,387,000	4,400,000	5,125,000
December,	1,253,600	2,642,000	4,376,000	5,255,000	5,877,000
	6,481,300	17,078,700	27,357,000	39,473,000	45,410,000

Total cubic feet, in four years and ten months, 135,800,000.

[E.]—*Consumption and sales of Gas in each year, in cubic feet.*

	1836.	1837.	1838.	1839.	1840.
Public Lights	978,812	1,397,687	3,013,546	6,280,654	8,028,818
Private do.	4,752,740	14,454,891	22,366,004	30,658,145	34,874,380
Works	90,000	200,000	250,000	380,000	500,000
Loss	11½ per cent.	6 per cent.	6⅔ per cent.	5½ per cent.	4½ per cent.
	659,748	1,026,122	1,727,450	2,154,201	2,006,802
Made	6,481,300	17,078,700	27,357,000	39,473,000	45,410,000

Brief statement of facts, connected with the Explosion of the Steam Boiler in the Sash and Blind Factory of Messrs. Pike and Perry, of Middletown, Connecticut, with remarks upon the cause of the Accident.*

FROM THE SENTINEL AND WITNESS.

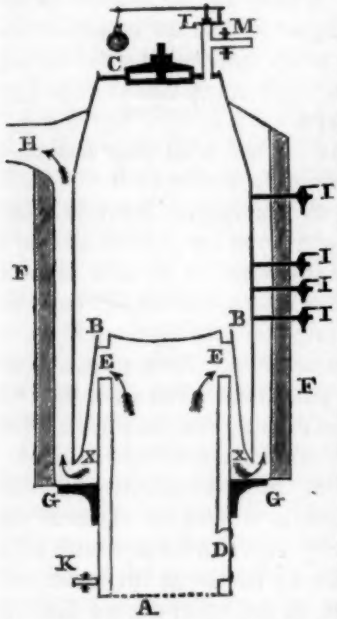
This accident occurred about half past eight o'clock on the morning of Tuesday, January 26th, 1841. The boiler which exploded was manufactured about a year ago for the Pameachy Manufacturing Company, by Guild and Douglas, of this city, and after having been in their possession about a month, it was sold to the present proprietors, who had it examined by the manufacturers, and the height of it increased, and commenced using it in June last. Since that time it has been in constant use, with the exception occasionally of a day or two. It was made of the best American iron, and was designed to be used at a pressure of about forty pounds to the square inch, but was supposed by the manufacturers, when new, to be capable of sustaining 200 lbs. to the inch without bursting.

The present engineer took charge of the engine several months since; we cannot state the precise time, but not till some time after it had been in the possession and use of Mr. Pike. And as we cannot, in giving this statement to the public—a statement which we think they have a right to demand, avoid expressing an opinion upon his conduct in connection with the catastrophe, we will take the opportunity now to say that we feel little disposition to censure him. That he is entirely free from blame we cannot affirm; but, careful as he is admitted to have been generally, as well when in the employ of others, as during his connection with Mr. Pike, it was his misfortune (as will, we think, soon be shown) to make a mistake where others, perhaps even more careful than himself, might have done the same. He affirms—and the fact so far as we know is not disputed—that some time in September or October last, during his absence a day from the shop, the person having charge of the engine allowed the water entirely to escape from the boiler, as it was found perfectly dry and leaky the next morning, and required some repairs before it could be used; and that he has been so fearful of it since that he has never ventured to risk so high a pressure upon it as he formerly did. Now it is not denied but that these facts are important, but we think other independent facts abundantly show that a very much higher pressure

* We are indebted to one of the honorary members of the Franklin Institute for forwarding this article. One of the Jury of Inquest, by whom it is drawn up, is well and favourably known for high scientific attainments. COM. PUB.

was required to produce the disrupture we have witnessed, than that to which it was ordinarily subjected. Whatever injury, therefore, the boiler may at that time have received—and we think it probably was more or less injured—we are still compelled to adhere to the opinion, that it could not have escaped its present fate, even if, at the time of the accident, it had possessed much more strength than it did when new.

But before proceeding further, in order to be understood, a description of the boiler must be given, the form of which will be seen by referring to the accompanying wood cut, which is designed to represent a section through the centre.



This boiler consisted of two parts, A, B, and B, C, each of which was six feet in height, making its whole height twelve feet. The part A, B, consisted of two concentric cylinders, one of which was placed within the other, leaving a space of two and a half inches between them to be filled with water, the cavity of the smaller constituting the furnace. At A, is the grate upon which the fire was kindled, D, the fire door, and E, E, flues, of which there were four eight inches in diameter, through which the smoke and heated air from the fire, passed, in the direction shown by the arrows. F, F, is a brick wall four inches thick, which inclosed the greatest part of the boiler, at about three or four inches distance from it, being supported by the strong cast iron plate G, G. H, flue for the smoke from the fire leading into the chimney. I, I, I, I, try-cocks, the first of which was placed six inches above the head B, B, and the others four inches apart, except the upper one, which was about a foot above the third one. The design of these was to show the height of the water, the surface of which was always to be kept above the lower, and below the upper one. These try-cocks, it will be seen, were required to be about a foot long, and were lengthened out by pieces of gun-barrel. K, pipe through which the water was forced into the boiler by the forcing pump; L, safety-valve, and M, steam-pipe, leading to the engine.

We are now prepared to understand the manner in which the explosion was produced, according to the opinion of the jury of inquest, and, it is believed, the unanimous opinion of persons who have critically examined the facts.

The explosion, as already remarked, occurred on Tuesday morning, January 26. The engine had not then been used, nor the boiler heated since the preceding Wednesday; and though the engineer, as usual, examined the boiler before kindling the fire, and, as he thought, found sufficient water in it to allow the engine to be started without pumping in any by hand, the probability is he was deceived, there being, in fact, but little in it. The probable cause of his mistake will be shown hereafter. It is not necessary to start any hypothesis to account for the fact of the water's being so low in the boiler at this time; if it was at the ordinary height when the engine was stopped on the Wednesday night previous, much of it might have escaped by a very small leak, in five and a half days.

The fire, as usual, this morning, was kindled with pine shavings, and pieces of boards, which not unfrequently produced such a blaze that it extended quite out of the top of the chimney. Being in a hurry to get the steam up, the engineer employed one of the hands to help him blow the fire a few minutes by hand, as he had done at other times. At length, by trying the safety valve, he found the pressure sufficient to commence running the engine, though not so high as they usually raised it before starting. Both pumps were started with the engine, one of which pumps the water from the well into the cistern, and the other from the cistern, into the boiler. The explosion took place about twenty minutes after the engine started.

Now if our supposition with regard to the small quantity of water in the boiler, when the fire was kindled, is correct, by the time the engine was started the parts immediately above the water must have been much heated; but would be gradually cooled as the water rose by the working of the pump, the steam in the boiler all the time increasing very rapidly. In the mean time the hot blast from the fire being driven fiercely by the blower (which forced the air in under the grate,) through the flues, E, E, would be heating intensely the part B, X, quite around the boiler, on which the water must have been suddenly dashed as soon as it rose to the edge B, to be converted into steam with explosive violence. The effect was much the same as if a quantity of gunpowder had been exploded in the boiler. The safety valve, under such circumstances, would afford no relief; and the result we have witnessed was the inevitable consequence. The engineer was probably deceived as to the height of the water in the boiler by the peculiar construction of the try-cocks, which, as we have

seen, passed through a brick wall four inches thick, and the space between this and the boiler, being nearly a foot in length. They were, of course, capable of containing considerable water, especially if they declined a little outward as it is believed they did; and this will probably account for all the water that was obtained from them that morning. If they were emptied once, being colder than the boiler, the steam, as soon as it formed, would be condensed in them again, and water might be drawn from them several times, successively. True, the engineer affirms he was aware of this, (which we are not disposed to dispute) and took the necessary precaution to avoid such a mistake, but though we give him full credit for honesty in making the statement, we think we are warranted in adhering to our own opinion. Indeed, in the hurry and bustle which confessedly occurred that morning in getting up the steam, it is not so much to be wondered at that the mistake should be made.

The rupture took place by the tearing of the iron around the edge at X, chiefly on the inside, but a part of the way the pieces separated directly at the edge, by the removal of the heads of the rivets and enlargement of the rivet holes. We are inclined to the opinion that the peculiar form of the boiler rendered it liable to yield here first, independently of the supposed fact of its being very considerably heated at the time of the accident, which must necessarily weaken it still more. The iron itself, in the opinion of competent judges, shows unequivocal indications of having been at a high temperature; and is rent and torn in such a manner as clearly to indicate the enormous force that was required to produce the effect.

The boiler seems to have yielded all around very nearly at the same time, and the part thrown off, was, therefore, thrown nearly perpendicularly upward. The slight inclination it took to the northeast may have been occasioned by its yielding a little sooner on one side than it did on the other, or by the resistance it met with in passing through the floor and roof of the building in which it was situated. On one side, four feet of the edge, where the rupture occurred, is fairly rolled up in the form of a cylinder.

The part of the boiler thus thrown from the building is computed to weigh about 1,500 or 1,600 pounds, and fell at the distance of ninety feet from its original position. So many different opinions have been expressed with regard to the height to which it rose, that means have been taken to determine it as accurately as possible, by actual measurement. Several persons saw it while in the air, some, when at its highest point, and others as it was falling; but without some mark by which to designate its actual position either at its culminating point, or some other precise point of time, it is difficult now

to ascertain the angle of elevation. One observer at the creek saw it under such circumstances, that he could scarcely mistake in identifying its true angle of elevation when at the highest point, which, by measurement, is found to give a height of 223 feet above the ground at the factory. According to the observations of others, who, however, saw it under less favourable circumstances, its greatest height would seen to have been something less than this. On the whole, we shall not exceed the truth in saying it rose from 200 to 220 feet.

Some attempt has been made to determine the height to which it rose by ascertaining the time it was in the air; and this method would be very correct if the time could be determined accurately. This, however, is very difficult, as under such circumstances it is nearly impossible for persons to form any opinion of the lapse of time, and are always prone to over estimate it. In the present instance, some persons who heard the explosion, and either heard or saw the boiler strike the ground, thought it must have been in the air a minute, others, half a minute, and others estimated it at only a quarter of a minute, but the last estimate would have given it a height (making no allowance for the resistance of the atmosphere,) of more than 900 feet. It probably was in the air about seven and a quarter seconds.

But our article is increasing to an undue length, and we refrain from adding more, except merely to say, that in preparing it we have had no personal or party purposes to serve. Our statement is made with the best of feeling towards all parties concerned. The facts stated, with the exception of one or two unimportant points, which will not be disputed, were fully established before the jury of inquest. If they do not seem to any one fully to confirm our opinion of the cause and manner of the accident, we may be allowed to remark that there are many other facts and considerations, all of which tend to confirm our views, that cannot be compressed into a single article like the present.

We have been assisted in determining the height of the boiler, by Prof. A. W. Smith.

JOSEPH K. F. MANSFIELD,
JOSEPH BARRATT,
JOHN JOHNSTON,
} Committee appointed by the Jury of Inquest.

Civil Engineering.

Letters from the United States of North America on Internal Improvements, Steam Navigation, Banking, &c., written by FRANCIS ANTHONY CHEVALIER DE GERSTNER, *during his sojourn in the United States, in* 1839.

[Translated from the German, by L. KLEIN, Civil Engineer.]

[CONTINUED FROM PAGE 173.]

LETTER X.

Cape May, New Jersey, July 29, 1839.

My ninth letter, dated from Cincinnati, contained a description of the rail roads in Belgium, and a comparison of the same with those in the United States;* in the present, I intend to give a sketch of the rail roads in the other parts of Europe.

1. *Rail Roads in Austria.*

The first rail road constructed in Austria for the transportation of passengers and freight, is that between the Moldau and Danube, or from *Budweis to Lintz;* the project for the same originated in the proceedings of the commissioners from the ten States bordering on the river Elbe, who met at Dresden in 1819, in consequence of the congress act of Vienna, and held a convention for the regulation of the navi gation upon the Elbe. The free navigation upon this river commenced in 1821, and the commission at Dresden had, before its dissolution, applied to the Austrian government with the request, to regulate also the navigation of the river Moldau as far as Budweis, and to establish from that point to the river Danube, a canal or rail road, in order that goods may be transported upon this line of communication from Hamburg to the Danube, and back. In the year 1822, I was requested by the President of the Court of Commerce, to place myself at the head of this undertaking, and proceeded immediately to make the local reconnoissences. I then went to England to consult there upon the best plan of locating the rail road over the mountains which divide the waters of the Moldau and Danube, and which have an elevation of 1000 feet above the surface of the water on the one, and of 1500 feet on the other side.

At that time, the engineers in England were unanimously of opinion that every rail road which leads over a mountainous country, must be composed of horizontal or nearly horizontal sections, connected by

* This letter the author has translated into English, at the request of some friends of internal improvements, to whom the contents were shown; it was afterwards, in consideration of the important information it embraced, republished in the Journal of the Franklin Institute. See page 145, vol. xxiv.—2d series.

steep inclined planes, which are to be worked by stationary steam engines. My explanation, that I regarded a rail road, in the principles of its construction as well as its ultimate objects, as nothing more than a very good turnpike road, and therefore could, in no case, agree to the adoption of inclined planes, was entirely disregarded.

I returned from England in November, 1822, superintended, during the following two years, the necessary surveys, and obtained, on the 7th of September, 1824, from His late Majesty, Emperor Francis I, a charter for the construction and management of a rail road between the Moldau and Danube. In March, 1825, I formed a company of stockholders in Vienna, and completed, up to the end of 1828, the first thirty-nine miles of this road from Budweis to the summit. The principles upon which this section was constructed, were, to have no greater ascent than forty-four feet per mile, (1:120,) and no smaller radius of curvature than 622 feet; finally not to lose again any ascended height. As the road was intended principally for the transportation of salt, the superstructure was made of wood, with flat bars fastened upon longitudinal sills, and the adopted maximum rise was founded upon the experience, that the railway cars, as they were then constructed, commenced at that inclination on plate rail roads, to descend by their own gravity. In the fall of 1828, the section of thirty-nine miles was opened, and used, as intended, with horse power.

Plain as these principles of construction must appear to every body, and though their results realized all expectations, propositions were made for altering the same, and adopted by the directors of the company without further inquiry. I therefore once more explained in a report, published in February, 1829, the motives for adhering to the former principles, and proposed, at the same time, the introduction of light locomotive engines for carrying on the transportation on this road; but my propositions were disregarded by the directors, who prefered to have the other section of the road, from the summit to Lintz, constructed on a plan in which grades of 115 feet per mile, (1:46) were adopted for considerable distances, ascended heights were lost again, (the road was made undulating,) and curves with radii of sixty feet were frequently introduced. In the year 1832, the whole line of eighty miles in length was put in operation, and since that time, has been used without interruption, in summer and winter, although the country is covered with snow through five months in the year. The company had formerly let the transportation of salt and merchandize to a contractor, who received three kreutzer in silver per 100 lbs., on those thirty-nine miles of road, the construction of which I had superintended; this is equal to one and one quarter cents per ton, per mile; after the opening of the whole line, never less than

ten kreutzer was paid for double the former distance, or eighty miles, which is at the rate of two cents per ton per mile; and there can hardly be any body, from the engineer to the cart driver, who, in passing over this rail road, does not sincerely regret, that the principles adopted in the construction of the first half of it, were not adhered to in the construction of the other half. The company would thereby have saved at least one cent per mile for every ton of goods transported, which, for 25,000 tons, per annum, would amount to 20,000 dollars, while the additional cost of the road, if constructed according to my principles, would have been only 120,000 dollars; besides it is now impossible to use locomotive engines upon this rail road, which would be of the greatest advantage, since wood is so cheap in this section of country. There certainly exists no other rail road, neither in Europe nor in America, on which the principles of construction were so different in its two halves, and where the consequences are at the same time so apparent; and it is to be wished for the sake of instruction, that a great many persons may visit this road, and convince themselves of the results of both plans of construction.

Under these circumstances, it is surprizing that this rail road, which has cost 800,000 dollars, or 10,000 dollars per mile, has paid, since its opening in 1833, *five per cent.* annually, on the capital expended in the construction, although only 6000 passengers, and 25,000 tons of goods, (principally salt,) are conveyed annually, over the same. If 925,000 dollars, or 11,562 dollars per mile, had been expended for the construction, the profit would have been six and one half per cent., and with the application of locomotive engines, perhaps eight per cent. on the cost of construction. The stockholders of this rail road labour under the disadvantage that a part of the capital was obtained in loans on short terms, while another part was received for shares, sold below their par value; the dividends for the first subscribers are thereby lessened, and will be sufficiently large only after the debts are liquidated.

The rail road from Budweis to Lintz, was afterwards continued to the salt depots, in Gmunden, and forms now an uninterrupted line of 130 miles in length, which has been for three years in full operation. The plate rails of this road are of the same dimensions as on many of the American rail roads, upon which locomotive engines are used without difficulty; but unfortunately, the road from Lintz to Gmunden has also been constructed upon such principles as will exclude the use of locomotives for ever. The total cost of the whole rail road of 130 miles in length, is 1,170,000 dollars, or 9000 dollars per mile, which appears very low, considering the great number of bridges and frequent rock excavations. Upon the road from Lintz to Gmunden,

95,000 passengers, and 40,000 tons of goods were conveyed last year, and the income, on the same, is therefore far greater than on that from Budweis to Lintz.

In the year 1826, the construction of a rail road *from Prague to Pilsen*, in Bohemia, was commenced; it was intended for the transportation of wood from the forests of Prince Turstenberg, and of coal from the vicinity of Pilsen; the length of the projected line was eighty miles; the limited means of the company, however, allowed only the construction of the first thirty-five miles, and the rail road was then publicly sold, to pay the debts of the company. At present, the rail road is used only for bringing wood and building materials to the city of Prague. I here take occasion to remark, that I have never been in any connection with this work.

The public, in Austria, expended for the above named rail roads, of 165 miles in length, about 1,500,000 dollars, at a time when the other States of Germany had not even thought on the introduction of rail roads. By the construction of this road, which, in part, traverses very difficult sections of country, they have acquired in Austria an experience, which, if judiciously applied, must be followed by the best results; and already these rail roads have called forth those undertakings, which are, at present, executed in Austria on a much larger scale than in any other State in Europe.

The first great rail road now in progress in Austria, called "*Emperor Ferdinand's North Road*," extends from Vienna to the salt works in Bochnia, (Galitia,) and will be 310 miles in length; the section from Vienna to Brunn, of 100 miles, is already opened, and they are actively engaged in the prosecution of the work. Last year, the directors of the company estimated the cost of construction of this rail road, at 20,000 dollars per mile, it will, however, not fall short of 25,000 dollars per mile, or of 7,750,000 dollars for the whole line. As the greater part of this capital is already paid in, the whole road will undoubtedly be completed in the course of a few years. The continuation of this line to *Cracow* will then likely follow, and for a rail road from *Cracow to Warsaw*, the Russian government has already granted a charter.

The second important rail road now under construction in Austria, is that from *Vienna to Raab*, (in Hungary,) which, with the branches to Baaden, Glocknitz, and Oldenburg, will have a length of 170 miles. With the considerable amount of capital at disposal, it may be expected that this rail road will also be completed within a few years.

At this moment, there may be 300 miles of rail roads in operation in Austria, and double as many miles will be in operation in the course of three years.

2. *Rail Roads in the other German States.*

Besides the rail roads in Austria, the following have been established in Germany, for the transportation of passengers and freight, and are partly in operation:

1. The *Nuremberg and Furth Rail Road*, four and one half miles in length, though very short, gave, nevertheless, for the stockholders, the best results ever obtained on any rail road in Europe. The population of Nuremberg, is only 38,000, that of Furth, 25,000, and the number of passengers upon the rail road, were:

In 1836,	449,399;	the dividends,	19 per cent.
" 1837,	469,304;	"	17½ "
" 1838,	439,889;	"	17 "

2. The *Berlin and Potsdam Rail Road*, fourteen miles in length, has cost 1,000,000 dollars; it has been opened, partly, on the 21st of September, 1838, and in its whole length, on the 29th of October, 1838. Up to the 29th of December, of the same year, the number of passengers transported, were 102,119. This rail road will, if well managed, give very favourable results.

3. The *Leipzic and Dresden Rail Road*, of 71½ miles in length, was opened on the 8th of April, 1839. The capital stock is 3,150,000 dollars, and the company had, besides, the right to issue bank notes to the amount of 350,000 dollars. The great cost of this rail road, which will not be short of 50,000 dollars per mile, has its cause in the great unevenness of the country through which the road has been located; but on the other side, a very great traffic may be expected upon it. Although only six miles of this road were opened on the 24th of April, 1837, and afterwards merely small sections at both ends, the number of passengers has been:

From 24th of April to 31st of December, 1837, -	145,674
In the year 1838, - - - -	365,870*

4. The rail road *from Brunswick to the Hartz*, is constructed by government, and will be thirty miles in length. The section from Brunswick to Wolfenbuttel, of eight miles, was opened on the 6th of December, 1838, and the number of passengers, to the end of that year, was 24,600.

5. The *Dusseldorf and Elberfeld* rail road, of thirteen miles in length, is undertaken with a capital of 700,000 dollars. Unfortunately, at the advice of the engineer, Robert Stephenson, an inclined plane was made in the middle of this road, which, as I have formerly observed, is in contradiction with the experience in America. On the

* According to a report lately published by the Directors, there were transported over the Leipzick and Dresden rail road, during the year 1839, 411,531 passengers, and 131,936 cwt. of merchandize, the total receipts were 262,282 dollars.

20th of December, 1838, the section from Dusseldorf to Erkrath was put in operation.

6. The *Magdeburg and Leipzic rail road* is seventy-five miles long, and constructed with a capital of 2,000,000 dollars; a part of this road will be opened in the course of this year, the remainder, in 1840.

7. The rail road *from Cologne to the frontier of Belgium*, forty-three miles in length, is located through a very difficult section of country, and its cost is estimated at 3,500,000 dollars; the completion of this road may not take place before two or three years. Cologne will then have a rail road communication with the harbours of Ostend and Antwerp, (in Belgium.)

8. The *Munich and Augsburg* rail road, forty miles in length, is constructed with a capital of 1,200,000 dollars, and will be completed in the course of the year.

9. The *Taunus rail road, from Frankfort to Mentz*, and Wiesbaden, is undertaken with a capital of 1,300,000 dollars, and will be twenty-six miles in length; it will likely be completed in the spring of 1840.*

10. In the Grand Duchy of *Baden*, a very extensive rail road is now under construction, through the whole length of the State, at the expense of the government, and as, at the same time, a rail road is constructing through Darmstadt, there will be, within a few years, a continuous rail road from Frankfort, on the Main, to Basle, in Switzerland.

There are some other small rail roads in different parts of Germany, upon which, however, nothing but coal, iron ore, &c., is transported.

The cost of construction, and even the length of the above named rail roads, cannot be accurately stated, as scarcely any of the lines is entirely completed, or, at least, buildings, locomotives, cars, &c., are still wanted on them. The average of the cost of the several rail roads, as above stated, is 47,000 dollars per mile; but when they are all in full operation, their cost will be found to amount to 50,000 dollars per mile; and perhaps to more. The cost of a mile of rail road, with a single track, in Germany, is, therefore, two and a half times greater than in America. If we take into consideration the extremely low wages of all classes of workmen, in Germany, but at the same time, also, the greater unevenness of the country, and compare both with what they are in America, we cannot but regard the works in Germany as very expensive, and I must, after mature deliberation, refer again to those causes by which the American rail

* A part of this road, from Frankfort to Hoechst, was opened in September, 1839, and the whole line in April, 1840. Up to the 1st of July, the number of passengers were 281,510, yielding an income of 50,000 dollars.

roads are so much cheaper, and which were stated in my fourth letter. It is for the fear of a too great expenditure, that no other rail roads are now undertaken in Germany, and that so many good and useful projects were abandoned. Amongst the projected rail roads, with the locality of which I am somewhat better acquainted, I mention the *Rhine and Weser*, the *Berlin and Stattin*, and the rail road from *Berlin to Frankfort, on the Oder.* These lines might, with the assistance of the great experience acquired in America, be constructed for such sums as would insure a good profit to the stockholders.

3. *Rail Roads in France.*

The most extensive rail road line in France, is that from *Lyons to Roanne*, which was constructed by three companies, and is thirty-eight lieues in length; the Epinac rail road is six and one half lieues, and the Paris and St. Germain rail road four and three quarter lieues long, while the total length of the other rail roads in operation, will hardly amount to eleven lieues; France has, therefore, at present, only sixty lieues, or 150 miles of rail roads in operation.* The most expensive of these roads is that from *Paris to St. Germain*, which is only 18,400 metres, or 11½ miles in length, and has cost 14,860,000

* The following is a list of the rail roads in France, at the close of 1839:

a.) Rail roads completed.	Length in metres.		Miles.
From St. Etienne to Andrezieux,	22,000	or	13,66
" St. Etienne to Lyons,	58,000	"	36,02
" Andrezieux to Roanne,	67,000	"	41,61
" Nimes to Beaucair,	24,000	"	14,90
" Montbrison to Montrond,	15,500	"	9,62
" Paris to St. Germain,	18,400	"	11,43
" Paris to Versailles, (right bank,)	18,572	"	11,53
" St. Vaast to Denain,	8,900	"	5,53
" Cette to Montpellier,	27,000	"	16,77
" Mulhouse to Thann,	19,660	"	12,21
" Creusot to the Canal du Centre,	10,000	"	6,21
" Villers Cotterets to Port aux Perches,	8,155	"	5,06
" Epinac to Bourgogne Canal,	28,000	"	17,39
" Alais to la grand Courle,	18,000	"	11,17
Total,	343,187	"	213,11
b.) Rail roads in progress, from Nimes to Alais,	46,319	"	28,77
From Paris to Versailles, (left bank,)	18,630	"	11,57
" Bordeaux to La Teste,	51,000	"	31,68
" Abscou to Denain,	5,940	"	3,69
" Strasbourg to Basle,	140,000	"	87,00
" Paris to Orleans,	120,000	"	74,53
	381,889	"	237,24

francs, or, per mile, 242,000 dollars. The part within the city of Paris, was, of course, the most expensive, but even after deducting the length and cost of this section, we find 165,000 dollars as the cost per mile, for the other part of the road, with a double track. Of the *Lyons and St. Etienne* rail road, which has also two tracks, the cost per mile, was about 70,000 dollars.

Upon the Paris and St. Germain rail road, 1,375,396 passengers were conveyed, from the 26th of August, 1837, up to the 25th of August, 1838, and the total receipts have been 290,834 dollars, or, per mile of road, 25,448 dollars; this gross income, per mile, is eight times as great as that upon the American rail roads, where it averages only 3075 dollars; but compared with the capital of construction, the gross income, in America, is fifteen per cent., and on the Paris and St. Germain rail road, only ten per cent. The French rail roads pay like the diligences, (stages,) ten per cent. of the gross income, as a tax to the State; the expenses of managing these roads, will, therefore, not amount to less than two thirds of the gross income, and the Paris and St. Germain rail road will hardly yield an interest of four per cent., if the traffic does not materially increase.

These are the causes why the rail roads projected in the spring of 1838, from Paris to Havre, from Paris to Orleans, and from Strasburg to Basle, for which the concessions were given by the Chambers, find so little support from the public, in France, that these projects will, it is likely, be entirely abandoned. The great mass of the population in France, is poorer than that in Belgium; and as the Belgian rail roads, with an average cost of 45,000 dollars per mile, yield only five per cent. on the capital of construction, the rail roads in France ought not to be constructed for more than 30,000 dollars per mile, if the capital of construction shall yield five per cent. interest. But to arrive at this, the principles of construction, hitherto followed, as also the now existing revenue laws in France, so injurious to every enterprize, require a thorough reform.

4. *Rail Roads in Holland.*

If the establishment of the rail roads in Belgium, belongs to the remarkable events of the age, it is still more the case with the rail roads in Holland. This interesting country is known to be intersected by navigable canals in every direction, and nowhere are better and more carefully maintained turnpike roads to be found. Nevertheless, the construction of a rail road from *Amsterdam to Harlaem* was commenced two years ago, and was nearly completed, when I visited Holland, in May, 1838, with the intention to inspect the large works of draining, which were undertaken near Gouda. The con-

struction of this rail road is the more remarkable, as there is between Amsterdam and Harlaem, a canal, upon which passenger boats are running, and close to it, a turnpike road. A width of track of four feet eight and one half inches, like that of the English railways, was intended for this rail road; but when it became known that the St. Petersburg rail road has a width of six feet, and the rail road from London to Bristol, even of seven feet, it was established by a decree of the government, that all the rail roads in Holland shall have a clear width between the rails of two metres, or six feet six and three quarter inches.

For a second rail road, from *Amsterdam to Arnheim*, along the Rhine, the concession was given by His Majesty, King William, with a guaranty not before heard of in any work of this kind; the King declared himself ready to guaranty to the stockholders, with his own private property, a dividend of four and one half per cent. per year. It is unnecessary to mention, that the whole capital was instantly subscribed.

[TO BE CONTINUED.]

Extracts from the Second Report of the Directors of the New York and Erie Rail Road Company, to the Stockholders, February 3rd, 1841. *Signed, by order of the Board of Directors, by* ELEAZAR LORD, ESQ., *President of the Company.*

CONTINUED FROM PAGE 194.

Of the Probable Income of the Road.

Instead of proposing simply an estimate of the probable number of passengers on this road, connected as it is, at its extremities, with the greatest sources and facilities of travel in the country, and throughout its whole extent, with tributaries from the right and left, or of the quantity of tonnage it may command, it seems appropriate to observe, that it occupies a route which is exempt from all hazard of competition; that it will accommodate an extent of country far larger than that which supplies the business of the Erie canal; that it is adapted to the object of tonnage as well as to that of travel; that besides the ordinary products of agriculture and manufactures, it will have large resources of business in the transport of minerals and lumber; and that the population within such distance of it, as to be relied on for its support, will not be less numerous than that which contributes to the toll, freight, and travel, on the Erie canal, and the works near its borders.

To illustrate the consideration last above mentioned, the following statements are submitted in the belief that the results will justify the utmost confidence in the productiveness and value of the work.

Statement of the population, by the census of 1840, of the counties traversed by the road, and of adjacent counties, and parts of counties,

to which it will be the most convenient route of communication with the city of New York.

Counties through which the Line extends.

Rockland,	11,874	
Orange,	50,733	
Sullivan,	15,630	
Delaware,	35,363	
Broome,	22,348	
Tioga,	20,350	
Chemung,	20,731	
Steuben,	45,992	
Alleghany,	40,920	
Cattaraugus,	28,003	
Chatauque,	47,641	
		340,385

Adjacent Counties in the State of New York.

Two-thirds of Otsego,	44,248	
Chenango,	40,778	
Cortland,	24,605	
Tompkins,	38,113	
One-third of Cayuga,	16,787	
One-third of Seneca,	8,289	
Yates,	20,442	
One-quarter of Ontario,	10,875	
One-half of Livingston,	17,855	
One-half of Genesee,	28,305	
One-quarter of Erie,	15,788	
		266,085
		606,470
Adjacent border counties of Pennsylvania, viz:—Erie, Warren, McKean, Potter, Tioga, Bradford, Susquehanna, Luzerne, Wayne, and Pike, and parts of some others; and in New Jersey, parts of Sussex, Passaic, and Bergen, estimated at		230,000
		836,470
Under the influence of the construction and use of the road, the increase in the above counties, in the next five years, may be safely estimated at 20 per cent. or		167,294
		1,003,764

The foregoing statement is made with reference to the state of things when the road is completed, and comprises considerable numbers within this State, which at present contribute to the support of the Erie canal, through the Chenango and Chemung canals, and by various land routes; for all which there is room for adequate allowance in the ensuing calculations.

By the census of 1830, it appears that the number of inhabitants in the above mentioned counties, and parts of counties, in this State, was - - - - 477,823
Increase in ten years, 27 per cent., or - - - 128,627

606,450

The increase in the State at large, during the same period, excluding the city of New York, was 23¼ per cent.; and in the city of New York, 50½ per cent.

In the eleven counties traversed by the road, the number of inhabitants in 1830, was - - - - 262,433
Increase in ten years, 30 per cent., or - - - 77,952

340,385

The number of acres of land taxed in the aforesaid counties, and parts of counties, in this State, in 1839, was 8,781,765
The number of acres taxed in the canal counties, and parts of counties, represented in the following statement, was, in 1839, - - - - - - 6,631,955

Statement of the population in 1840, of the counties which are traversed by, and other counties and parts of counties, which now are, and will, it is assumed, continue after the road is completed, to be tributary to the Erie canal.

Schenectady,	- - - 17,233	
One-third of Otsego,	- - - 17,124	
Montgomery and Fulton,	- - 43,839	
Herkimer,	- - - - 37,378	
Oneida,	- - - - 85,327	
Madison,	- - - - 40,067	
Oswego,	- - - - 43,820	
Onondaga,	- - - - 67,914	
Two-thirds of Cayuga,	- - 38,575	
Two-thirds of Seneca,	- - - 16,579	
Wayne,	- - - - 42,160	
Three-fourths of Ontario,	- - 31,876	
Monroe,	- - - - 51,912	
One-half of Livingston,	- - - 17,855	
Orleans,	- - - - 25,015	
One-half of Genesee,	- - - 28,305	
Niagara,	- - - - 31,114	
Three-fourths of Erie,	- - - 46,615	
		677,708

The number in the same counties, and parts of counties, in 1830, was - - - - - - 548,205
And in 1835, the number was - - - 646,197
Increase in ten years, from 1830 to 1840, 23½ per cent.
Increase in five years, from 1835 to 1840, 5 per cent.
With an increase of 5 per cent. in the next five years, the number will be - - - - - 711,593

If to 677,708 be added the inhabitants of the city and vicinity of

Albany, say 32,292, making 710,000, an increase of 7 per cent. thereon in five years, will make an aggregate, in round numbers, of 750,000.

The very moderate increase above noticed, of 5 per cent., between 1835 and 1840, is most probably to be accounted for, by supposing that the effect of the canal in drawing population within reach of its facilities, and in enhancing the price of farm lands from four or five, to fifty, eighty, or a hundred dollars per acre, according to position, had been realised prior to 1835; while the extraordinary increase of thirty per cent. in ten years, in the counties on the line of the road, indicates that the anticipation of that work, added to the very low price of lands in those counties, had induced emigration thither.

If to the population to be immediately accommodated by the rail road as above stated, viz: - - -	836,470
be added that of the city of New York, in 1840, viz:	312,832
and that of Brooklyn and vicinity, say - -	45,718
The aggregate will be - - - - -	1,195,020
The increase of which, in the next five years, supposing the road to be completed and in full operation within that period, may be safely estimated at 25 per cent., making in round numbers - - -	1,500,000

It is, therefore, abundantly manifest that a population not less, but more numerous than that by which the canal and its route is used, is to be accommodated, and relied on for the support of this road.

Now the tolls annually collected on the Erie canal and its branches, exclusive of the Champlain canal, amount in round numbers, to - - - - -	$ 1,500,000
The cost of freight on the canal is, at least, three times as much as the tolls, or - - - - -	4,500,000
The amount of fares paid by the population using the canal for passage in boats, and on the rail and other roads along its route, cannot be estimated at less than three dollars each per annum. The population using the canal route at the present time, may be estimated with sufficient accuracy by adding to the number in the canal counties as above stated, viz. in 710,000, for those from other counties and parts of counties, who, through branch canals and otherwise, now use the route of the Erie canal more or less, both for travel and transport, a number equal to about one half of the 606,450 assigned to the rail road within this State, making in round numbers $ 1,000,000; which at three dollars each, amounts per annum, to - - - - -	3,000,000
Total, - - - - -	$ 9,000,000

which is equal to an average of nine dollars each, per annum, for travel and transport on that route, or about 12 per cent. of the value of the commodities transported.

In 1839, 1,435,713 tons were transported on the canals, valued at $ 73,399,764, on which the tolls received amounted to $ 1,616,382, of which $ 113,753 were collected on the Champlain canal.

The tolls actually collected on the canal, being the basis of this estimate, and the results being, after large allowances, sufficient to justify the inferences to be made from them, it is immaterial whether the numbers stated as now using the canal, or the rates of fares paid, be exact or not. No reason is perceived why it may not be safely taken as a basis of calculation with reference to the rail road and Southern tier of counties. The inhabitants of those counties are not less industrious or less enterprizing than those of the counties which border the canal. Their lands, for all the purposes of agriculture, with exceptions in respect to wheat, are superior to those of the canal counties; their climate is more uniformly salubrious; and in their rivers, their forests, and their minerals, the difference is still more widely in their favour. If there be a reason, it is not apparent, why they should not have occasion to travel as much, and as far as their Northern neighbours, to procure for themselves a like quantity of supplies, and to pay for them by sending their products to market; or why they should not be able and willing to pay as much annually, for travel and transport, if favoured with facilities adapted to all their objects, interests and wishes, and available from the Atlantic to the lake, in winter as well as summer. If the products of their agriculture are at present less, their lumber and their minerals are far more abundant. The railway will, to say the least, furnish them facilities of travel and transport as much more eligible and convenient than any others within their reach, as the canal and the road, along its route, do those using and supporting them. For through passengers passing West from the city of New York, and East from the lakes and Western States, the prospects of the road cannot be well deemed inferior to those of the canal route, whether distance, time, expense, or comfort be most regarded.

There would seem, then, to be nothing very extravagant in anticipating for this road, which will be competent to as much business, and combines all the objects of the canal and the rail and other roads on its borders, an amount of income not vastly disproportioned to the amount paid for tolls, freight, and travel on that route, as above represented.

To those, however, who may think it most prudent to suppose the inhabitants of the Southern counties to have fewer wants than their neighbours, less ability to supply them, and less occasion and leisure for travel, it may be more satisfactory to estimate their payments for the same objects, at six, or at four and a half, instead of nine dollars each, per annum. At six dollars each for 800,000, the amount would be $4,800,000. At four dollars and fifty cents, it would be $3,600,000.

Supposing then that a single track of the road finished in the best manner, with a heavy edge rail, and competently furnished with engines, cars, and all the requisite appurtenances, should cost $ 9,000,000, the above estimate of six dollars for each inhabitant, deducting one-third, or $ 1,600,000 for expenses, which is deemed more than sufficient for such a road, would give an annual net income, on the cost, of thirty-five per cent. At four dollars and fifty cents each, the net income would be over twenty-six per cent. per annum. If only three

dollars each be assumed, which would require the supposition that the travel and business of this population, would be but one-third as much as that on the route of the canal, the net income, after deducting one-third for expenses, would amount to about eighteen per cent. per annum.

To judge of the claims of any such undertaking, and especially of rail roads, because they offer the greatest facilities for travel, and likewise for transport, when properly constructed for that object, it is essential to inquire, first and chiefly, to what number of people will the work in question afford the most satisfactory means of travel and business. This may involve two subordinate inquiries; one, whether, and to what extent, the route is exposed to competition; the other, as to the tendency of the work to augment and multiply the employments and business of those who are relied on for its support, and to attract farther accessions to the population.

Where there are people enough for its support, a road adapted to their purposes, and so conditioned as to command their patronage, will, of course, be productive. The number of people to be served is, in connexion with the length of the road, a far safer basis of calculation than any general or theoretical estimate of passengers and tonnage. There may be a great difference on different routes in the variety and extent of the employments and business of the people; and a more numerous population may be required on some routes than on others, to afford daily a sufficient number of passengers, in addition to their tonnage, to support a road. On a route through a salubrious and inviting country, occupied by a prosperous and increasing population, and affording scope and objects for ten times their numbers, a railway is a far safer investment than on a route which, though equally populous at the outset, presents no new objects of enterprise, or inducements to immigration. On a road long enough to yield, on an average, five dollars for each passenger, two hundred passengers a day, with their tonnage, would probably yield a better income on the same capital, than twenty-five hundred per day, on a short road, yielding but fifty cents a passenger. A road requires a given number of passengers yearly, with their tonnage, to render it productive. If there are on its route people enough, their character, circumstances and employments being considered, to supply that number of passengers, and if growing numbers and patronage are in the given case to be relied on, in connexion with the use and influence of such road, its success is certain.

Such a case is presented by this road. There is no mode of estimate or calculation on such a route, occupied by such a population, that will not justify all that need be claimed or presumed for this.

One consideration has, however, been omitted, which merits notice, and which, from its important bearing on the subject, did not escape the attention of the intelligent and practical men who have added most liberally to the subscriptions of the past year—namely, that on all that portion of the cost of the work which is discharged by capital borrowed, the annual dividend is limited by the rate of interest on the loan—consequently the dividends on the company's

stock will be larger in proportion as the earnings of the road exceed the rate of interest on the loan. Thus, if the income of the road is equal to ten per cent. on its cost, it will pay six per cent. on two-thirds of the amount, and eighteen per cent. on the balance.

Aware of the operation of this method, and of the security it gives at once to stockholders and to the lenders of capital, railway companies in England, in cases where the density of the population insures an abundant income, even on roads costing ten to twenty times as much per mile as this will cost, and where they find no difficulty in disposing of their stock to any required amount at a premium, limit the issue of shares to a portion of the expenditure, and supply the balance by loans.

It may still be gratifying to some to have before them an estimate of the number of passengers required at a given charge for fare to support this road.

If then there should be, including way and through passengers, a number equal to one hundred and five through each way per day, making for both ways sixty-six thousand a year, at twelve dollars each for four hundred and fifty miles, or about two and a half cents per mile, the receipts would amount to - - - -	$792,000
And if the interest on $6,000,000, at 5½ per cent., be deducted, viz. - - - - -	330,000
The remainder - - - - -	$462,000
will divide over 15 per cent. on $3,000,000 of stock.	
At eighteen dollars each, or four cents per mile, the balance will divide 28 per cent. on $3,000,000.	
If the number of passengers be equal to one hundred and fifty through each way per day, or one hundred thousand a year, the receipts at twelve dollars each for fare, would amount to - - - - - -	$1,200,000
and interest be deducted as before - -	330,000
The remainder - - - - -	$870,000
will divide 29 per cent. on $3,000,000 of stock.	
And at eighteen dollars each, the balance will divide 49 per cent. on the stock.	
Should the city of New York, the counties on the route, and the regions beyond, furnish passengers equivalent only to fifty through each way per day, or thirty-three thousand a year, the receipts at eighteen dollars each, or four cents per mile, the rate usual on other roads, would amount to	$594,000
interest being deducted as above - - -	330,000
The balance - - - - -	$264,000
will divide 9 per cent. on $3,000,000.	

As an illustration of the matters involved in these estimates, it may be observed that on the Utica and Schenectady railroad, seventy-eight miles in length, the number of through passengers, in 1839, was - - - - - 95,776
and of way passengers - - - - - 86,823

Total - - - - - 182,599

equal to 125,102 through passengers; the fare through being three dollars, or a fraction short of four cents per mile. It is understood that the passengers transported on that road are estimated at not more than one-fourth of the whole number that pass between Utica and Schenectady, on the canal and otherwise, per annum.

The expenses of the year amounted to less than 30 per cent. of the receipts. The balance, after deducting all expenses, amounted to more than 15 per cent. on their capital. Had half of their capital been borrowed at 6 per cent., the earnings of the year, after paying the interest on the loan, would have divided 25 per cent. on the stock; or paid off the loan in four years of like receipts; or divided 10 per cent. per annum, and paid off the loan in six years.

The number of through passengers, as stated above, divided by the number of miles in the road, gives an average equal to 1604 passengers per mile yearly, 134 per mile per month, and 31 per mile per week.

100,000 through on this road would give 224 passengers per mile yearly, 19 per mile per month, and 4½ per mile per week.

66,000 through would give 147 passengers per mile yearly, 12 per mile per month, and 3 per mile per week.

33,000 through would give 73 passengers per mile yearly, 6 per mile per month, and 1½ per mile per week.

On the Boston and Worcester road, forty-one miles in length, the average in 1839 would be 2195 passengers per mile yearly, 183 per mile per month, and 42 per mile per week.

On the Boston and Lowell, twenty-six and a half miles in length, in 1838, 4905 passengers per mile yearly, 409 per mile per month, and 94 per mile per week.

On the Camden and Amboy, sixty-one miles in length, in 1839, 2984 passengers per mile yearly, 249 per mile per month, and 57 per mile per week.

Utica and Syracuse, fifty-three miles in length, in 1839, 2302 passengers per mile yearly, 192 per mile per month, and 44 per mile per week.

The number of way passengers on the Utica and Schenectady railroad amounted, in 1839, to 86,823.—The gross revenue derived from them was $87,979 57, amounting to $1.01 for each individual; and as the charge for a through passenger is three dollars, it is seen that the way passengers traveled, on an average, one-third the length of the road. It may be assumed as nearly self evident, that in a country occupied by a population distributed evenly over its surface, and having a uniformity of character and pursuits, the railroads which traverse it will receive numbers of way passengers proportional to their

lengths; that is, a straight road two hundred miles long will have twice as many way passengers as a road one hundred miles long. If we apply this principle to the case of the New York and Erie railroad, we may estimate the number of its way passengers from that on the Utica and Schenectady road, in the following manner, viz:

Miles. Miles.
78 : 446 : : 86,823 : 496,449 = number of way passengers on the New York and Erie railroad. If we suppose the distance traveled by the above number of persons to be the same in proportion as on the Utica and Schenectady railroad, the average journey for each will be one hundred and forty-eight miles. At four cents per mile the sum paid would be $5.92, and the amount per annum received from all the way passengers would be $2,938,978.08.

To illustrate this view of the subject still farther, we will make a similar estimate from data furnished by the Utica and Syracuse railroad. The length of this work is fifty-three miles; the number of way passengers in 1839 was 55,802, who paid on an average seventy-three cents each, the price for a through passage being two dollars. By extending the calculations as above, we shall find that the number of way passengers on the New York and Erie railroad would, at the same rate, be 469,579, and the sum received from them, $3,056,959.

The amounts obtained in these calculations agree sufficiently to show that with regard to the railroads cited, the rule that the numbers of way passengers are as the lengths, holds good.

The mean of the two results is about $3,000,000, from which, if we were to deduct one-third for expenses, we would have a net receipt of $2,000,000 on way passengers alone; equal to 22 per cent. on the capital; or if two-thirds of the cost of the work were defrayed from loans, at 5½ per cent., the income on the remaining $3,000,000 of stock would be 55 per cent. per annum. In other words, if the New York and Erie railroad shall receive as many way passengers in proportion as the Utica and Schenectady, and Utica and Syracuse railroads, the net earnings might be more than sufficient to pay 5½ per cent. on $6,000,000 of loans, and 50 per cent. on $3,000,000 of stock, and this without taking into account the profits on through passengers, on freight or on the transportation of the mail.

Nothing can illustrate more forcibly than this the advantages which long roads possess over short ones. The results obtained may seem extravagant, and it is not intended to be asserted that they will from the first be realized; but when it is remembered that the Utica and Schenectady railroad has, to the north of it, a country which, as yet, yields very few passengers, and that on the south side it is in immediate contact with the Erie canal, which, during seven months of the active portion of the year, divides with it the way business, and that the Utica and Syracuse railroad, having the same competition with the canal to sustain, has also the inconvenience of being constructed for nearly half its length across swamps which are at present uninhabitable, whereas the New York and Erie railroad is every where free from these disadvantages, it cannot be deemed unreasonable that we

should expect to profit to a very considerable extent from the principle above set forth.

The Boston and Lowell road is one of the best in the country, and is worked as cheap, or cheaper, than any other, in proportion to its length. But it is short, and notwithstanding its heavy business, both in passengers and tonnage, pays but about nine per cent. per annum on its cost.

Of the railroad stocks in England, which are offered for sale, as quoted in the London Mining Journal, Railway and Commercial Gazette, of the 26th of December, 1840, all those which appertain to railways, of which the length is thirty miles or more, and which have been completed and in operation one year or more, are at a premium, viz:

Stockton and Darlington, 38 miles, including branches; opened, 1825; price, £275 per £100 paid up, premium, 175 per cent.

Liverpool and Manchester, 31 miles; opened, 1830; price, £185 per £100 paid up; premium, 85 per cent.

Grand Junction, 82½ miles; opened, 1837; price, £212 per £100 paid up; premium 112 per cent.

London and Birmingham, 112 miles; opened, 1838; price, £169 per £90 paid up; premium 87½ per cent.

London and Southwestern, 76¼ miles; opened, 1838 and 1840; price £54 per £30 paid up; premium, 40½ per cent.

Great Western, 117½ miles, of which 63½ are finished; opened, 1838 and 1840; price, £89 per £65 paid up; premium, 37 per cent.

New Castle and Carlisle, 61 miles; opened, 1839; price, £105 per £100 paid up; premium, 5 per cent.

The stocks of a number of other roads which exceed thirty miles in length, up to one hundred and twenty-six miles, are quoted at various rates below par, but most of them are but partially constructed, and none of them had been completed and opened prior to 1840.

Of the numerous roads which are less than thirty miles in length, the stocks, without exception, are quoted below par.

Analogous to this, is the experience on this side of the Atlantic. Though the cost of roads here is comparatively small, and their character as to routes, grades, curves, and superstructure, is quite various, it is believed that not more than two or three that are forty miles or more in length, and have been finished and in use twelve months, are unproductive; among which, the only one in New England, or New York, is that from Stonington to Providence. Their earnings vary from 6 to 15 per cent. Some shorter roads are known to be productive, but it is deemed quite safe, and due to the subject, to state that of the roads which are completed and in use, those which are not productive are short ones.

The report of the Western railroad corporation of Massachusetts, dated March, 1840, states that the net income of the railroads, finished in that Commonwealth, averages over 8 per cent. per annum on their cost.

In 1839 the net income of the Utica and Schenectady road was 15 per cent.; of the Utica and Syracuse, 14 per cent.; of the Camden and Amboy, 13¼ per cent.

The foregoing estimates of passengers on this road, are made on the supposition that the freight both ways would pay the repairs and all other expenses, which may be taken at one-third of the receipts, or assuming the largest of these estimates, at $400,000 a year.

On the Erie canal, in 1839, about 160,000 tons of merchandise, products of animals, seeds, &c., were transported, of the value of $45,000,000, as stated in the report of the commissioners; and about 340,000 tons of manufactures, vegetable food, &c., exclusive of lumber, valued at $17,000,000, making 500,000 tons of the above mentioned articles, valued at $62,000,000.

The 160,000 tons of merchandise averaged in value $280 per ton, and would, it may be reasonably presumed, be transported on a railway properly constructed for tonnage, in preference even to an adjacent canal, on account of its value, the difference of time occupied in its passage, certainty of calculation as to its arrival, less risk of damage, convenience in respect to the engagements and affairs of those owning it, and other considerations of more or less force in different cases.

The 340,000 tons of manufactures, &c., averaged in value about $50 per ton, and would assuredly be transported on a railway on the shortest route to market were there no canal on such route.

Let it then be supposed, that of the above descriptions of articles, quantities should be transported on this road, equal only to 100,000 tons through per annum, and that the rate of profit on the transit of them should be one per cent. per ton per mile, the net receipts in such a case would be $450,000, or more than enough to defray the supposed amount of annual expenses.

Or if by being in operation five months of the year more than the canal, 50,000 tons of merchandise for the interior of this and the western and southwestern states, should be transported over the road at a profit of two cents per ton per mile, the like sum of $450,000 would be received.

It is therefore deemed as plain as success elsewhere or here can make it, that excluding all reliance on lumber, coal, and other minerals, there is room for the highest confidence of an abundant income. It is believed, however, that when the road is in full operation, from 100,000 to 200,000 tons of coal, and a like quantity of lumber, will be transported on it, on an average 150 miles; and that the number of passengers and the whole amount of tonnage will very far exceed the highest of the preceding estimates.

Architecture.

On Glass as applied to Architecture.—Extract from a Lecture on the Architecture of the Middle Ages, delivered before the Franklin Institute, by **T. U. WALTER,** ***Professor of Architecture, December*** **10, 1840.**

"The first ancient writer by whom any mention is made of glass as an artificial substance, is Theophrastus, who wrote about 300 years before Christ; he describes it as having been made of the sands of the river Belus, and seems to have had considerable knowledge of its nature. About a century later, we have a description of the celebrated *sphere* of Archimedes, which, if the account of it be true, goes to show that the art had then attained to considerable perfection.

Lucian speaks of drinking glasses, and Plutarch, Lucretius, Virgil, Horace, Strabo, Seneca, and Pliny, all mention glass; indeed Pliny, who wrote in the 77th year of Christ, gives a full description of the way in which it was then manufactured; he says that some forms were brought into the required shape by blowing with the breath, some were ground on a lathe, and others were embossed—Sidon, he tells us, was formerly famous for these manufactures, and *specula*, or looking-glasses, were first invented there. He further remarks, that no substance was more manageable in receiving *colours*, than glass, and that it might be cut, or engraved upon by diamonds. The Apostle Paul also alludes to glass, in his first letter to the Corinthians, written about the year 57, and the language he uses clearly indicates it to have been a substance through which objects could not be discerned with distinctness.

We have no positive authority relating to the use of glass for *windows*, earlier than the close of the third century. St. Jerome, who wrote in 422, speaks of windows formed of glass melted and cast into thin plates; and in the year 571, Gregory of Tours alludes to the devastations committed on the windows of churches, by the ravages of war. Johannes Philoponus, who is supposed to have written about the same time, speaks of the panes of glass being fastened in the windows with plaster.*

Felibien, in his "*principes de l'architecture,*" says that the first attempts at ornamenting windows with figures, were made by arranging glass of different colours, like mosaic, and that the beautiful effect thus obtained, led gradually to the art of infusing various tints into each pane, so as to produce compositions of any required design.

Fortunatus, who lived towards the end of the sixth century, speaks

* Rees' Cyclopædia.

in glowing terms of the painted glass in the windows of the church of Notre Dame, at Paris; and Benedict Biscopius is said to have imported the art into Britain in the year 675.

Stained glass was not, however, connected with architecture to any great extent, until the reign of the third Henry in England, in the thirteenth century, and it reached its zenith under the kings of the house of York, in the fifteenth century.

A popular idea prevails that the art of staining glass was lost, but such is not the fact. When architecture began to decline, under the Tudor family, all the arts connected with it declined also, as a natural result. Felibien, who wrote as long ago as the year 1699, says, that in ancient stained glass, some very beautiful and very lively colours are seen, which are not now to be found; it is not, however, that the invention is lost, but because persons will not incur so great an expense, or take the same pains to make them, that they formerly did.*

Dallaway says, very plainly, that the idea of the art having ever been lost, "*is a vulgar error,*" it is practised at the present day as perfectly, and as beautifully, as in any preceding age.†

From this cursory glance at the introduction of glass in building, we find that architecture went through all its earliest stages in the east, attained the zenith of its glory in Attica, and sunk in ruin with the city of the Cæsars, before glass was used at all as a material for keeping out the weather, and transmitting light; hence *classic* architecture ran its whole course without any influence whatever from this invention; while, on the other hand, *Gothic* architecture depends for *its* character almost exclusively upon it. To the introduction of glass in building, may, therefore, be attributed much of the wide difference which exists between classic and gothic architecture."

Franklin Institute.

Minutes of the Board of Managers.

At a meeting of the Board, held at the Hall of the Institute, January 17th, 1841,

Mr. James Henry Bulkley was elected Chairman, and

Messrs. Henry Troth and John S. Warner, Curators, for the ensuing year.

At a meeting of the Board, held February 17th, 1841, the Chair-

* Felibien's principes de l'architecture, p. 182.

† Dallaway's Discourses upon Architecture in England, p. 63.

man nominated the Standing Committees agreeably to the By-Laws. On motion—Alfred L. Elwyn, M. D., was added to the Committee on the Library; Professors Jas. C. Booth and Jno. F. Frazer to the Committee on the Cabinet of Minerals; Messrs. Thomas S. Stewart and John M'Clure to the Committee on the Cabinet of Models; Professors James C. Booth and John F. Frazer and Mr. Joseph Saxton to the Committee on the Cabinet of Arts and Manufactures; Messrs. Samuel V. Merrick and Matthias W. Baldwin to the Committee on Publications; Professor Henry D. Rogers to the Committee on Instruction; Professor Roswell Park, Robert Hare, M. D., John K. Mitchell, M. D., Mr. Joseph Saxton, Mr. Andrew M. Eastwick, and Professor John C. Cresson to the Committee on Monthly Meetings; Gouveneur Emerson, M. D., Mr. Sears C. Walker, and Professor Roswell Park to the Committee on Meteorology; when the Committees were appointed as follows:

On the Library.

Henry Troth, *Chairman*,
Isaac Hays, M. D.,
Isaac P. Morris,
Ambrose W. Thompson.
Thomas U. Walter,
Alfred L. Elwyn, M. D.

On the Cabinet of Minerals.

Charles B. Trego, *Chairman*,
Isaiah Lukens,
Abraham Miller,
Samuel Hufty,
Henry D. Rogers,
James C. Booth,
John F. Frazer.

On the Cabinet of Models.

Isaac P. Morris, *Chairman*,
John Agnew,
Andrew M. Eastwick,
Thomas U. Walter,
John H. Towne,
Thomas S. Stewart,
John M'Clure.

On the Cabinet of Arts and Manufactures.

James C. Booth, *Chairman*,
Alexander Dallas Bache,
Charles B. Trego,
John Struthers,
John H. Towne,
Edwin Greble,
John F. Frazer,
Joseph Saxton.

On Publications.

John C. Cresson, *Chairman*,
Isaac Hays, M. D.,
Samuel V. Merrick,
Alexander Dallas Bache,
Matthias W. Baldwin,
Isaac P. Morris,
Ambrose W. Thompson.

On Premiums and Exhibitions.

Thomas Fletcher, *Chairman*, John S. Warner,
John Struthers, John Gilder.
John Agnew,

On Instruction.

Alex. Dallas Bache, *Chairman*, Charles B. Trego,
Frederick Fraley, Henry Troth,
John Wiegand, Henry D. Rogers.

On Monthly Meetings.

Roswell Parke, *Chairman*, William H. Carr,
Alexander Dallas Bache, John C. Cresson,
Robert Hare, M. D., George Taber,
John K. Mitchell, M. D., John H. Towne,
Joseph Saxton, James Hutchinson.
Andrew M. Eastwick,

On Meteorology.

Gouveneur Emerson, *Chairman*, Henry D. Rogers,
John C. Cresson, Roswell Parke.
Sears C. Walker,

On Finance.

Samuel V. Merrick, *Chairman*, Matthias W. Baldwin,
Frederick Fraley, Henry Troth.
Abraham Miller,

Managers of the Sinking Fund.

Samuel V. Merrick, *Chairman*, Frederick Fraley,
Matthias W. Baldwin.

Auditors.

Isaac B. Garrigues, *Chairman*, William H. Carr,
Ambrose W. Thompson.

(Extracted from the minutes.)

J. Henry Bulkley, *Chairman.*

William Hamilton, *Actuary.*

Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN FEBRUARY, 1840.
With Remarks and Exemplifications by the Editor.

1. For a *Self-tending Saw Mill;* Edwin Moody and Samuel Morrill, Andover, Merrimac county, New Hampshire, February 8. Several patents have been granted for objects similar to that had in

view by the patentees of this mill, namely, to perform all the motions necessary in setting the log, and actuating the other parts of the machine, without labour on the part of the tender, whose only business will be to place a new log on the carriage, and to remove the stuff as it is sawn up. The manner of doing this is, in the present instance, represented in twenty-two figures in the drawings, and the claims are to a number of special arrangements, referred to by letters, and not, therefore, affording, if given alone, any idea of the means by which the design is carried out.

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2. For machinery for *Sawing Stone;* David V. Rannells, Washington, Mason county, Kentucky, February 8.

This machinery is intended for sawing stone either into square, cylindrical, or columnar, blocks. Many machines have been contrived for this purpose, both in ancient and modern time. The patentee is limited, therefore, in his claims to the special arrangements devised by him. These we shall not attempt to describe, for two reasons; first, from the difficulty of doing so, clearly, without the drawings; and secondly, because we do not perceive in this machine any thing that is likely to bring it into extended use, if into use at all, excepting for the purpose of essaying it. We have seen marble sawed cylindrically, but so far as our observation and information extend, machines for this purpose are rarely used, although descriptions of them are to be found in the books, and this would not be the case were they found to save labour.

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3. For *Dressing Mill Stones;* Robert M. Smith, Rutherford county, Tennessee, February 8.

This patent is taken for the particular manner of laying out the furrows, the claim being to "the giving to all the furrows the same draft, as described; and also in giving the furrows a crook, or elbow, at a point about midway between the verge, or periphery, and the eye of the stone, for the purpose, and in the manner, described." Numerous patents have been taken for modes of laying out the faces of mill stones, most of which, undoubtedly, have been indebted for their supposed value to the imaginations of their contrivers, as they have not gone into extended use; such, we apprehend, will be the fate of that before us.

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4. For *Preventing and Checking Fires;* L. Bush, administrator of Isaac Lowell, Pendleton, Niagara county, New York, February 12, not issued until October 16.

The patentee tells us that the nature of his invention "consists in taking water from a cistern, reservoir, well, or from any other source, and conducting it by pipes, over, in, through, and upon, any and every portion or section of a building, internally and externally, in such a way as that in a few minutes the whole surface, externally and internally, may be covered with water, and a constant flow of water be

kept up for any length of time, by receiving the water back into the reservoir, and using it over and over again;" and all this to be effected by a machine which "for buildings of ordinary height may be worked by one man. Two men can work a machine calculated for the highest building."

The foregoing reminds us forcibly of the announcements made by the Marquis of Worcester in his "Century of Inventions," but we are not, in the present instance, as in the case of the Marquis, left to invent the machine over again, as, for our perfect edification, we have it described and represented in drawings. We cannot give the views, or speculations, of the inventor, at any extent, but he tells us that the "*simplicity*" of his machine "is such that the whole expense of one will be trifling, compared with the expense of any machine now in use, designed for the same purpose, and will bring it within the means of almost every person to have one permanently attached to his building." "The inventor claims as new, and as his invention, the arranging of pipes along the roofs of houses, having apertures to admit of the water flowing out upon the roof, for the purpose of extinguishing fires; the water being forced into said pipes by a double acting force pump, as described, or by any other means substantially the same."

The reader who does not perceive the absolute absurdity of the foregoing plan, by which one, or two, men are to deluge a building with water, both internally and externally, has not yet mastered the horn books of mechanics, and hydraulics, and such we cannot take the time to instruct. One of the most amusing parts in the whole matter is the idea of collecting the water that has been once used to extinguish a fire, and of using it over again. The modus is not given.

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5. For improvements in *Buckles, Clasps, Hooks and Eyes, &c.;* William Church, a citizen of the United States, residing in Great Britain, February 18.

"These improvements consist, in the first instance, in the adaptation of a lever to the buckle, as a substitute for a pointed tongue; and in the second instance, in the adaptation of a spring stop to a clasp, catch, or other fastening, for the purpose of retaining the connexion between the two parts when united, or in a holding position." "The improvements in clasps, catches, hooks, or other such fastenings, consist in the adaptation of a spring stop, having a double inclined plane, which, when the two parts of the clasp or other fastening are put together, shall prevent their separation until a force is applied sufficient to push the staple past the inclined part of the spring." The devices proposed to be used are represented in twenty-nine separate figures in the drawings, the claim, however, is a very limited one, being to "the application or substitution of the lever which pinches, or presses, the strap, in place of the ordinary tongues, or points, entering, or piercing, the strap, or bandage, as has been the case heretofore."

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6. For a *Portable Grist Mill;* Isaac Straub, Cincinnatti, Ohio, February 18.

"My first improvement consists in the addition of an elastic bridge tree to the ordinary bridge tree, by which the spindle is raised and lowered, which additional bridge tree I usually make of a strip of wrought iron. My second improvement consists in the manner of affixing and running the spindle, said spindle being sustained by a permanent step at its lower end, and by an adjustable quarter bush at its upper end; there not being any bush, or support, between its two extremities."

The claim is to "the additional bridge tree, made of wrought iron, or other elastic material, having on its upper side the step of the spindle, its ends being attached to the base of the frame, and the raising and lowering of it being effected by the ordinary bridge tree, in the manner set forth."

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7. For constructing *Ships, Brigs, &c.;* George F. Bigelow, Norfolk, Virginia, February 18.

The following is the substance of the specification of this patent, that part only being omitted which consists of references to the drawings, and which are not necessary to a clear understanding of the proposed plan.

"Be it known that I have invented an improvement in the manner of contructing ships, brigs, and vessels of all kinds, either for sea or river service, by which improvement they are, whether large or small, built upon an established principle, which, it is believed, will be found in practice to furnish vessels which will pass through the water with less resistance, and to possess greater stability, than those built upon any other plan.

"The principle upon which I proceed and upon which my improvement rests, is that of making all the water lines of my vessel of whatever kind it may be, segments of circles. In carrying out this principle rigidly, the stem and stern, or fore and aft parts of my vessels will have the same form, and the greatest breadth of beam will be exactly amidships. Should it, however, be desired to have the greatest breadth of beam either forward, or abaft, of this point, it may be effected to any desired extent by adopting two different curves in each of the water lines; in which case the shortest end will become a segment of a curve of smaller radius than that of the longer end; the variation of the radius being governed by the distance to which the greatest breadth of beam is removed from midships; a variation which will not, in the slightest degree, affect the principle upon which I proceed, namely, that in passing through the water, the lines by which said water is divided by the forward part of the vessel, and those also by which it flows in towards the stern, shall both, whatever may be the draft of the vessel, be simple segments of circles.

"Although it is not absolutely necessary to the carrying out of my principle of construction, that the stem and stern posts should rise vertically, or nearly so, from the keel, I prefer so to plan them, as by this means a greater degree of strength may be attained, and I am well assured that a vessel so formed, will pass through the water

with equal facility as one under the ordinary construction. This observation applies more particularly to the stem of the vessel, or cutwater, as usually formed.

"Having thus fully described the nature of my invention, and shown the manner in which I carry the same into operation; what I claim as constituting my improvement, and desire to secure to myself by letters patent, is the so constructing of ships, and all other vessels, either for sea or river service, as that all the water lines, from stem to stern, either from midships, or from that part having the greatest breadth of beam, shall consist of segments of circles, as herein set forth."

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8. For a machine for *Cutting Veneers;* William R. Greenleaf, and Alonzo C. Gerry, in the Town of Gerry, Chatauque county, New York, February 18.

The veneers are to be cut in this machine by means of a long stiff knife, fixed obliquely across a sliding gate; and the patentees say, "we are well aware that machines with sliding gates, and knives, for cutting shingles, staves, and other kinds of thin stuff, are in use, but they are not capable of cutting the kind of veneers referred to, in consequence of the knives not being sufficiently stiff, or unyielding; in this respect, we believe, our machine differs very essentially from all others; and also in the construction of the feeding works." The claims are to the method of holding, and adjusting the piece from which the veneer is to be cut, by means of sharp pointed, and blunt screws. The mode of bringing the stuff forward, and the mode of setting the knife by socket set screws.

This machine can be applied to short stuff only, being limited to the convenient length of the knife, which must, of necessity, operate across the grain. It is proposed to steam the wood, and this would, undoubtedly, be necessary in all curley stuff. The general construction of this machine not being new, the claims, it will be seen, are limited to matters of detail, giving but little security, as there would be no difficulty in varying these so as to avoid all interference.

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9. For *Oiling Mill Spindles;* Elijah W. Welsh, Paris, Fauquier county, Virginia, February 18th.

This patent is taken for an improvement on a former patent, dated January 28th, 1840. In the additional specification, we are told that "the oil is admitted through an aperture closed by a screw; or it may be admitted through the collar;" and the claim is to the "mode of oiling the necks and bushes of mill spindles; that is to say, by the described combination of the circular box, hollow stem, and hollow spindle neck, with the square fountain containing the oil and bush."

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10. For *Measuring for Garments;* Daniel Williams, city of New York, February 18th.

This patent is also for an improvement upon the plan for which a

former patent was granted, dated the 26th of April, 1839. The claim made is to "the combination of the graduated slide, and segment, with the instrument originally patented, substantially as the same is described, such combination being intended to indicate the proper position of the upper point of the fore part, shoulder seam."

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11. For *Saddles with elastic Seats;* Charles King, Mount Pleasant, Jefferson county, Ohio, February 21.

In this saddle there is a flat plate spring placed behind the cantle, and attached thereto at its middle; its two ends rising to a distance from the cantle. These ends are connected by screw rods and nuts to two girths, which pass along to the fore part of the saddle tree, under the seat; these girths may be tightened by means of the nuts upon the rods, which pass through the cantle for that purpose. The ends of the springs are covered, and hidden, by leather casings behind the cantle, which may be opened when it is desired to regulate the force of the springs. The claim is to "the mode of connecting the springs behind the cantle with the webbing within it, and regulating the tension of the same by means of the ⊥ bolts passing through the cantle and spring, with the nuts on the ends thereof, as set forth." This is a more neat and simple, and, we think, a more effective mode of forming a spring saddle, than most of those which have been previously patented.

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12. For a machine for *Punching Iron;* Samuel Davis, Mifflin, Juniata county, Pennsylvania, February 21.

This machine is intended, principally, for punching sheet iron for manufacturing stove pipe. A follower, carrying a series of punches, is brought down by means of a combined lever and cams. The perforated dies upon which they operate, are in separate pieces, and they, and the punches, may be renewed at pleasure. The claim is to the special arrangement of the respective parts, as described, there not being any novelty in the general plan of operating a number of punches at the same time.

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13. For a *Lime Kiln;* Isaac Richardson, Paoli, Chester county, Pennsylvania, February 21.

This kiln differs from many others only in the manner of arranging the flues, as indicated in the claim, which is to "the manner of constructing and combining the flues below the ash pit, so as to admit the air at the back as well as at the front and sides, in a lime kiln for burning anthracite on grate bars, by natural draft; governed as set forth, the other parts of the kiln being constructed substantially, as described."

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14. For a machine for making "*Wrought Iron Spikes;*" John M'Crone, Ellicott's Mills, Baltimore county, Maryland, February 21.

"The general arrangement of this machine does not differ materially from some others, and I therefore do not claim it as of my invention, but what I do claim, is the gripping of the spike upon the two stationary dies, by the two movable dies, with the arrangement for removing it, when completed, by the action of the finger; constructed, combined, and operating, in the manner set forth. Also the particular arrangement and combination of the heading apparatus, consisting of the lever, working shaft, and slide, operating by a crank on the end of the main shaft, as set forth."

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15. For an improvement in *Weaver's Harness;* John Thorp, and William G. Angell, Providence, Rhode Island, February 26.

This patent is obtained for an improved manner of using the knotted heddle stuff, of which weaver's eye harness is made. The claim is to "the chain of knotted heddle stuff of which weaver's harnesses are intended to be made, as described, also the connecting by knots, or half knots, the two pieces of wire, so as to form eyes suitable to be used in making weaver's eye harness."

The subject is not illustrated by drawings, yet it seems to be a case which "admits of drawings." We must suppose, however, as it has been passed by the office, that the thing patented did not admit of being drawn, and that the description, although to us somewhat obscure, would be clear to a professional weaver.

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16. For an *Endless Chain Bucket Wheel;* John Dutton, Jr., Aston, Delaware county, Pennsylvania, February 26.

This patent is obtained for a proposed improvement on a plan of using an endless chain of buckets, attached to a band, or strap, and passing around two drums, in the manner of flour mill elevators. The improvement, so called, consists in making the front of each bucket double, a space being allowed between the two metallic plates of which it consists; this opening is to operate like a funnel, for the purpose of conducting any water which may spill over from the front edge of any one of the buckets, into that immediately below it. The claim is to "the construction of the spout on the outside of each bucket for preventing a waste of water, by conducting that which runs over the edge of the bucket after it is filled, to the bucket below." This is a claim upon which to obtain a patent, but as the general plan has been found inferior to the employment of an overshot wheel, which it is intended to supersede, we apprehend that the *improvement* will not suffice to bring it into general use; the complexity of this apparatus, and its consequent liability to get out of order, which have condemned it for more than a century, still remaining.

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17. For a machine for *Raising Stumps;* John D. Akin, Columbus, Warren county, Pennsylvania, February 26.

The claim to this machine is limited to "the employment of an eccentric wheel for bringing the machine above, or moving it from, a stump, in a sideway direction; constructed, and operating, as de-

scribed." The general plan of applying power by means of a windlass and chain, is that adopted, and in a way which does not present any thing of a novel character; the eccentric wheel, which is the only thing claimed, does not appear to be a very important feature in the machine, and the purpose for which it is used may be equally well attained without it.

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18. For a *Truss for Hernia;* Moore R. Fletcher, Boston, Massachusetts, February 26.

The plan of adapting the pad to the ruptured part, which is the main subject of this patent, does not differ materially from the manner of adjusting truss pads, to the particular case of the wearer, which has been before employed; but the difference has been deemed sufficient to justify its being made the subject of a patent, the claim under which is to "the attaching of the pad spring to a wheel, as described, and by this means rendering the pad movable, so that it can be placed in any required position. Also the mode of varying the amount of pressure on the pad, by means of the screw passing through the rivet and pressing against the pad spring. Also the combination of the spring rider with the wheel and pad spring, and their further combination with the truss spring. The whole being constructed, and operating, as set forth."

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19. For an *Excavating Machine;* Joseph Hanchett, Coldwater, Branch county, Michigan, February 28.

"The nature of this invention consists in combining together a common wagon, with a rising and falling frame containing ploughs for loosening the earth, and turning the same into the buckets of a revolving vertical wheel placed behind the forward plough, and at the side of another plough; which wheel elevates the earth and deposites it at the side of the excavation, or into a box or receiver on said wagon, or into a cart. Also in shaping the side of the ditch by trail cutters behind; the whole being drawn forward by animal power." The claim is to "the before described combination and arrangement of the elevating wheel, ploughs, adjustable frame, and inclined trail cutters, for excavating and cutting ditches."

This plan will, we are convinced, add another to the many abortive attempts which have been made to construct excavating machines for ditching and embanking, or for loading the excavated earth into carts, or other vehicles. We are aware that there are in operation some very useful machines for excavating, but we do not know of any completely successful effort to accomplish the purposes proposed by that before us. The object is one of great importance, particularly in the prairie regions, and there are several individuals now at work seeking to obviate the objections to the machines heretofore essayed. We think that they are, in general, aiming at more than they will be able to effect, but doubt not that some valuable improvement will be made in this department of engineering.

Specifications of English Patents.

Specification of a patent granted to Rice Harris, *of Birmingham, for certain improvements in Cylinders, Plates and Blocks, used in Printing and Embossing.* [Enrolled, Nov. 12, 1840.]

This patent is,—1st, for the manufacture of cylinders, plates, and blocks, made of, or coated with glass, enamel, or other vitrified substances, containing silica, boracic acid, or either of them, sufficient to render such cylinders, &c., capable of being acted upon by hydrofluoric acid, alone or in combination with ammonia, or other base. The cylinders thus produced, being used for printing or embossing of linen, woollen, silk, or other similar fabrics. 2nd, the application of tubes or linings for cylinders made of copper, brass, or other expensive materials, for the purpose of economising those metals. The glass cylinders, &c., are made in the following manner; twenty-eight parts (by weight) of clean Isle of Wight sand; thirty-five parts of red lead; fourteen of soda ash; seven of nitrate of soda; seven of calcined iron scales; seven of refined borax; seven of calcined copper; seven of oxide of manganese; and twenty parts of pulverized flint glass, are melted together in a large crucible or pot, in a glass furnace. When these ingredients have become fused, and the whole, or nearly the whole, of the volatile gas has been disengaged, the fluid mass is transferred to smaller pots for the convenience of casting. A cast-iron mould, in parts, is provided, its internal diameter being that of the cylinder required, and furnished with an inner core or tube, through which a current of cold water is continually flowing to prevent the fusion of the tube. When the melted glass is poured into the mould, a solid cylindrical piston is forced down upon it by a strong vertical screw, in order to compress and solidify the mass. The cylinder thus formed, is to be annealed in a kiln of the usual kind, by being placed in a case of iron rather larger than the cylinder itself, and surrounded with finely-powdered charcoal; this case is to be suspended within the kiln, so that the cylinder may be uniformly annealed all over. Or, the cylinder may be annealed in the mould in which it was cast. The cylinder is then to be smoothed and polished in the manner usually adopted in glass polishing.

Cylinders, plates, &c., may also be made of other materials, and coated externally with some suitable vitrified substance, capable of being acted upon in like manner by the acid. The cylinder, &c., produced in either of these modes, may be engraved upon the surface in the usual way of engraving glass, or may be etched by treatment with the acid; in the latter case, the parts not to be acted upon are protected by wax or other suitable etching grounds, and the cylinder immersed in hydro-fluoric acid; by this means the pattern, in relief for printing, or sunk if for embossing, is produced upon the surface, and the cylinder being mounted on a mandril or axis, is ready for use. In the formation of metal cylinders upon the plan here patented, tubes or linings of iron, or compressed wood, are put into cylin-

ders of brass, copper, or other suitable metals, thereby reducing the quantity of the more expensive materials. The external brass or copper cylinder has a lining cemented throughout its length, furnished at each end with a screw projecting beyond the cylinder for receiving two caps or nuts, which attach it securely to the cylinder. A rib or feather upon the lining tube fits into a corresponding groove upon the axis or mandril, in the usual way of mounting printing cylinders.

Mech. Mag., Nov., 1840.

Specification of a patent granted to HENRY MONTAGUE GROVER, *of Boveney, Buckingham, for an improved method of retarding and stopping Railway Trains.* [Enrolled, Nov. 2, 1840.]

The "method" here patented, if not an improved, is at least an abundantly "singular" one. From the lower frame of the carriage or truck, a wooden block or box is suspended by a bar link, within about half an inch, more or less, of the wheel; this box contains a large soft iron horse-shoe, enveloped with wire helices for converting into a powerful electro-magnet when its good offices are required. From these helices, wires proceed up into the carriage where a galvanic battery is situated, and with which they can be connected at pleasure. Should any accident or other circumstance render it expedient to retard or stop the train, connecting the wires with the battery converts the horse-shoe into a powerful magnet, which, hanging within a "striking distance," catches hold of the rim of the iron wheel, pressing itself and the wooden box against it, after the manner of the brakes usually employed. The patentee states that these electro-magnetic brakes may be applied to one or more of the wheels of a train, or the apparatus may be applied to one wheel, and its action transmitted to other wheels by means of levers. We apprehend Mr. Green has greatly underrated the extent of power required to arrest the progress of railway trains, and the electro-magnetic power capable of being obtained by the means he proposes.

Ibid.

Specification of a patent granted to THOMAS GADD MATTHEWS, *and* ROBERT LEONARD, *of Bristol, for certain improvements in machinery or apparatus for Sawing, Rasping, or dividing Dye Woods or Tanners' Bark.* [Enrolled, Nov. 5, 1840.]

These improvements consist in certain arrangements of circular saws, by means of which, woods, or bark, are reduced to a finely divided state for the use of dyers and tanners, in a more economical and expeditious manner than has heretofore been effected. The peculiar feature of this invention is, combining a number of circular saws upon a rotary spindle in such a manner that although not in actual contact, they are placed so nearly contiguous to each other, that when a piece of wood, or a quantity of bark is brought under their operation, it will be sawn, rasped, or reduced to a finely divided state without leaving any veneer. The circular saws are mounted

on their spindle, and the space between each saw is filled up with pieces of wood, felt, metal, pasteboard, or other suitable substance; the saws are then secured between two cheeks by nuts and screws. The log of wood is placed upon an inclined plane, and made to slide down towards the saw by a pushing apparatus, consisting of a worm wheel, rack and pinion, driven by suitable gearing connected with the prime mover of the machine. A counterbalance weight is attached to the rack by a cord passing over a pulley, to facilitate its ascent up the inclined plane, for the introduction of a fresh log of wood. The claim is to the application of rotary circular saws to the sawing, rasping, or reducing to powder, of woods or bark, for the use of dyers or tanners in whatever manner the same may be applied. Ibid.

Specification of a patent granted to WILLIAM PEIRCE, *of James's Place, Hoxton, for improvements in the construction of Locks and Keys.* [Enrolled, Nov. 2, 1840.]

These locks, which are upon Barron's principle, with numerous tumblers, are furnished with a detector, consisting of a sliding bolt acted upon by any one or all of the tumblers; the opposite end of this sliding bolt is jointed to a small lever, mounted on a suitable axis. Within a tube, opposite the lower part of the key-hole, a dart, or sharp-edged punch is placed upon a strong spiral spring; there is a notch on the under side of the dart, in which the detector lever rests and holds the dart down upon the compressed spring. On attempting to open the lock with any but the original key, one or other of the tumblers is over lifted, which, acting on the detector lever, releases the dart or punch which flies out through the key-hole, wounding the hand that holds the key. The face of the punch being in the form of a letter or figure, inflicts a wound that for several weeks identifies the aggressor; these locks have therefore been termed *Identifying Detector Locks.*

In order to prevent the accumulation of dirt, &c., within the pipe of the key, a metal stop is fitted so as to work freely within it, being kept flush with the end of the pipe by means of an internal spiral spring, which yields to the pin of the lock when in use.

The claim is,—1st. The mode of constructing detecting locks. 2nd. The mode of applying spring stops to keys. Ibid.

Progress of Practical & Theoretical Mechanics & Chemistry.

Observations on Coal, the duration of its supply, and on its reproductive Power. By DR. WILKINSON, *Bath.*

During the debates on the Budget for 1838, Sir R. Peel remarked on the proposed reduction of duty on coal, in order to promote its exportation, that he was not satisfied of the abundant supply of coal

in this country. He knew that the reproductive power of coal was not so rapid as the consumption, whatever chemical combinations it might possess. Any observations made by this distinguished statesman are entitled to the most respectful attention. I presume, the most satisfactory reply will be by an inquiry into the formation of coal, from which may be deduced the degree of apprehension as to the duration of its supply; and whether any such apprehension may be diminished by any supposed reproductive power.

In some "Observations" I lately published on the green mineral naptha of Barbadoes, I introduced some new opinions relative to coal. These opinions have led to correspondences with many of my philosophical friends; and the result has been, that probably coal does not originate from vegetable matter. In those extensive masses of vegetables discovered at considerable depths below the earth's surface, or the beds of the ocean with its sub-marine forests, elevated by the agency of volcanic power above its water level, the wood assumes different characters, according to the conditions to which it may be subsequently subjected. In the vicinity of Bath, I have seen, under the blue lias, the same mass of wood undergoing different changes; that part which had not been under much pressure retaining its ligneous character—the next portion resembling the surturbrand of Iceland, or the Bovey coal of Devonshire—and the extreme part had exactly the character of jet, admitting of such a beautiful polish, that the present ingenious engineer to the Kennet and Avon Canal Company (Mr. Eastwick) made from it a series of primitive crystals. In the heath where Bovey coal is found, are numerous stumps and roots of trees, so that the coal appears to be the broken trunks and branches, which, by slow and gradual change from the vegetable character, are converted to that of jet or asphaltum. These changes appear to have resulted from the combined effects of water and pressure, without any agency of heat, the bituminous matter being retained; vegetable matter exposed to the action of water alone, undergoes a gradual change, blackens, and assumes a charred appearance. It is by such a process, the roots and stalks of vegetables, on heaths and morasses, are converted into turf; when deeper in the earth, then a slight pressure operates, that the roots and fibres become less distinct, the vegetable is resolved into a black extractive substance, and called peat; and when extensive masses are immerged at greater depths, then surturbrand, Bovey coal, &c., are formed. All these substances, when analyzed, yield those results which correspond to the elementary constituent parts of vegetables.

With respect to coal, the formations are so distinct, that they are always found in the same relative geological situation. It is found in a basin reposing on limestone, and never observed either on primitive or transition rocks, and in the analysis yields very different results; frequently are observed vegetable impressions in the schist above coal, yet no geologist has inferred from this appearance that the substance originates from the same organic source. In those extensive analyses which are daily conducted on a large scale at gas establishments, five elementary principles are invariably found—viz.,

oxygen, hydrogen, carbon, nitrogen, and sulphur; and, with the carboniferous limestone, millstone grit, and old red sandstone, constitute a series of associated rock formations, and with regular alternations. This is not the case with turf, peat, Bovey coal, &c. They are invariably found to result from binary or ternary arrangements of the three elementary principles—viz., oxygen, hydrogen, and carbon—and which we invariably find resulting from the destructive distillation of wood. In no instance are found in these substances either nitrogen or sulphur, nor are they observed to have any regular geological position. Turf and peat are found on the granite beds of Greenland and Iceland, and on the tertiary beds of France and England. Hericart de Thury describes some of these deposits in Dauphiny at 7000 feet above the level of the sea. The celebrated botanist, De Candolle, observed, that in Holland the turf is the result of sea weeds, and, in elevated districts, principally from the leaves of trees. Most of these are of recent formation; wood which has been worked, and tools of iron, have been found in the turtiary.

It must be admitted, that in coal-fields are observed representations of the trunks and stems of arundinaceous plants, also some participating of the palmaceous and of coniferous plants; and my late learned friend, Steinhauer, supposed he had discovered tubular acini or leaves in some of the calamites and portions of the phitolithus notatus. In these I have never observed any satisfactory ligneous characters, nor is it easy to conceive that, in such extensive imaginary woody masses, the vegetable part should be so effectually removed, and in lieu thereof earthy materials substituted, excepting a very thin tunic of carbonized matter, which certainly increases the difficulty attending the hypothesis of the whole mass being a cast corresponding in size to the supposed vegetable. When coal appears in the vicinity of rocks of igneous origin, as the Rowley rag, basalt, &c., its bituminous portion is volatilized, and it exists in a coke-like form; so also, when not reposing on its limestone bed, but on the lower red sandstone, it equally loses its principle of inflammation, and constitutes stone coal or culm, as seen in Wales.

Contemplating coal as a distinct rock formation, formed under certain conditions of the earth long anterior to man, we have no more reason for supposing any reproductive power, than that those portions of St. Vincent's Rocks which have been detached may be again restored. Thus, considering coal as not a vegetable product, or consisting of such principles as not to admit of any supposed power of reproduction, have we any reason to apprehend a serious exhaustion of this valuable material?

Let us take into our calculation the extensive coal-fields of Northumberland and Durham, Yorkshire, Warwickshire, Lancashire, Shropshire, Staffordshire, Cumberland, Somersetshire, Gloucestershire, and the counties of Nottingham and Derby, and, when to these we add the great supply afforded by Scotland, North and South Wales, we need be under no apprehension that, however great our consumption, still our supply is not only adequate to every purpose, but also

would justify Government in promoting exportation by every effort in their power. Min. Review, December, 1840.

On the Manufacture of Flint Glass. By Apsley Pellate, A. C. E.

Flint glass, called by the French "crystal," from its resemblance to real crystal, is composed of silex (whence the English name,) to which is added carbonate of potash and litharge, or red lead; to which latter material is owing, not only its great specific gravity, but its superior lustre, its ductility, and power of refraction.

It is necessary for optical purposes that flint glass should be perfectly free from striæ, otherwise the rays of light passing through it diverge and become distorted, and this defect is caused by the want of homogenity in the melted mass, occasioned by the difficulty of perfectly fusing substances of such different density as the materials employed. The materials being properly prepared, are thrown at intervals into a crucible of Stourbridge clay, which will hold about 1600 lbs. weight of glass when fused. The mouth of the crucible is then covered with a double stopper, but not luted, to permit the escape of the moistute remaining in the materials, as well as the carbonic acid gas and excess of oxygen. It requires from fifty to sixty hours application of a rapid, intense, and equal heat to effect the perfect fusion of the materials, and to drive off the gas; during which time the unfused particles and excess of salts are skimmed off as they rise to the surface. The progress of fusion cannot be watched, nor can any mechanical means for blending the materials during fusion be resorted to, lest the intensity of the heat requisite for the production of a perfectly homogeneous glass should be diminished, the quality of the product being influenced by any inattention on the part of the fireman, as well as by the state of the atmosphere, or of the wind. It has been ascertained, that there is a certain point, or crisis, of fusion at which the melted metal must be kept to insure a glass fit for optical purposes, and even when that point be attained, and the crucible shall furnish proper glass during several hours, should there be such diminution of heat as to require the furnace to be closed, the remainder of the metal in the crucible becomes curdy and full of striæ, and thus unfit for use. It is the same with the glass made for the flat bore tubes for thermometers, which are never annealed, because the smoke of the annealing furnace would render the interior of the bore unfit for the reception of the mercury. These tubes will only bear the heat of the blow pipe when they are made from a metal which has been produced under all the favourable circumstances before described. It is, therefore, to be inferred, that the most homogeneous and perfect flint glass can only be produced by exposure to an intense and equable degree of heat, and that any excess or diminution of that heat is injurious to its quality.

Flint Plate.—The English method of manufacturing the flint plate for optical purposes is thus described. About seven pounds weight of the metal is taken in a ladle of a conical shape from the pot at the

proper point of fusion, and then blown into a hollow cylinder, cut open, and flattened into a sheet of glass of about fourteen inches by twenty, and varying in thickness from three-eighths to one-fourth of an inch. This plate is afterwards annealed, and in this state goes into the hands of the optician, who cuts and grinds it into the requisite form. When a glass furnace is about to be put out, whole pots of metal are sometimes suffered to remain in it, and cool gradually. The crucibles being destroyed, pieces of glass may be cloven from the mass of metal, softened by heat, and made to assume the requisite form, and then ground. It is believed that the excellent glasses made by Frauenhoffer, and other manufacturers on the continent, are produced by some such means. On attempting to cut glass ware, it is easily perceived if it be sufficiently annealed; if not, the ware is put into tepid water, which is heated, and kept at the boiling point during several hours; it is then suffered to become gradually cold. This method is more efficacious than re-annealing by the ordinary means. A piece of unannealed barometer tube of forty inches in length being heated and quickly cooled, contracted only one-sixteenth of an inch, whereas a similar piece, annealed by the usual means, contracted nearly one-eighth of an inch. Unannealed flint glass, being heated and suddenly cooled in water, exhibits the appearance of a mass of crystals; it is thence inferred that the process of annealing renders the glass more compact and solid; it thus becomes incapable of polarization.

Railway Mag., December, 1840.

New Air Engine.

Both in England and France many unsuccessful attempts have been made to convert air into a motive power—Sir George Cayley has at length succeeded. The public will have an opportunity of judging for themselves of the value of this discovery, as soon as a locomotive carriage, now in progress of manufacture, can be got ready. The principle of the new engine is easily explained—the details we reserve for another occasion. Air is compressed by the pump into a receiver, to be used when wanted. Motion is communicated to the wheels by pistons acted upon by the air, which is rarefied by heat in its passage from the receiver to the cylinders, where it acts upon the piston rod much in the same way that steam does. Thus, to communicate motion to the piston, a portion of the air in the receiver is forced by compression into tubes subjected to heat, and from thence, in its rarefied state, it rushes to the cylinders as the only place of escape. Motion is accordingly produced. An experimental engine, upon this plan, was exhibited last year to Messrs. Babbage, Rennie, Gordon, Bramah, Renton, and others. It worked with great steadiness at rather above five horse power. The power, which was under perfect control, was capable of immediate increase or decrease, the expense of fuel following exactly the same ratio as the power, which is one of the peculiarities of this engine. If it were stopped for a minute, or any number of minutes, or for half an hour, no loss of fuel took place—that is

to say, no loss takes place while the engine stands idle. No water is required—a serious consideration; and the consumption of coke is only from four to five pounds weight per horse power per mile.

This experimental engine, though perfect as to power, was found inconvenient, in consequence of some of the dust from the coke getting into the working cylinders, which caused them to require more lubrication than was convenient for practical purposes. The engine now building is constructed upon a plan to do away with this evil, which appears to be the only remaining impediment to be overcome. The air engine, by obviating the necessity of carrying water, and by obtaining the full power from combustion in the most economical manner, bids fair to be applicable on many occasions where the steam engine is inconvenient, and to vie with it in power. We are extremely anxious to see the new machine at work.

Mining Journal, December, 1840.

Progress of Civil Engineering.

Experiments with Locomotive Engines, on the Hull and Selby Railway.

On Tuesday, the 10th instant, a course of five days' experiments commenced with the engines of the above railway, originating through the following circumstances:—

About the commencement of the present year, six engines somewhat similar to those on the Leeds and Selby line, were in greater or less state of forwardness for the Hull and Selby Railway, at the works of Messrs. Fenton, Murry, and Jackson, of this town, when the Hull and Selby Railway Company resolved to have six other engines, on the most approved construction which experience up to that period could produce, from the previous working of locomotives on the various railways. Four objects were particularly kept in view, namely, *safety*, *simplicity*, *accessibility* of the various parts, and *economy*, the whole combining general *efficacy* and *durability* of the engine throughout.

The first object is secured by giving a more extented *base* for the action of the springs in supporting the weight of the engine, being about six and a half by eleven feet, whereby a remarkably steady motion is secured at thirty miles per hour. It is not at all a matter of surprise that the four wheeled engines of several railways now in use should now and then go off the road, and in an instant, when it is recollected the extreme base of their springs for supporting the engine is only about three and three-quarters by about six feet; hence their rocking, serpentine, and pitching motion, which without any other cause than a slight increase of speed, literally lifts the flanches of the wheels above the surface of the rails, and in three or four seconds the engine is turned end for end, upset in the act, and the train with it; whilst the stability of the engine is effectually secured through an extended base upon the front and hind wheels. By means of a new

combination the best properties of the four-wheeled engines are also completely applied, by resting the weight on the crank-shaft immediately within the wheels, which experience has for years proved to be the least likely to injure it, and thereby avoiding the alarming accidents which have so often taken place by the breaking of the shaft, through placing the weight on bearings outside of the wheels; the centre of the engine being a sort of neutral axis, there is very little power over its motion in that part, and this advantage, by placing the weight on the crank inside the wheels, is in consequence got without a sacrifice of stability.

2ndly. In addition to the safety and simplicity of having only *two* inner frames, instead of three or four, with as many bearings on the crank shaft, the space under the boiler is still further stripped of machinery by a new valve motion, which gives a high degree of openness and facility of access so desirable in examination, cleaning, &c., of the working parts.

3rdly. The steam being used expansively by the valve motion above alluded to, a great saving in fuel is effected, as will be seen on examining the results of the experiments; and as the excessive wear and tear of locomotive boilers arise from intense heat, it is not improbable this decided step towards removing the cause will prevent the effect, namely, the rapid destruction of the boiler. The action of this valve motion is perfectly smooth, being worked by eccentrics (which are also of an improved construction,) and any quantity of steam from 25 to 90 per cent. on the stroke can be admitted into the cylinders with the most ready and complete control, at any speed the engine may be going; if a high wind, or an incline, opposes the progress of the engine, a greater quantity of steam is admitted; if wind or gradients be favourable, the steam is still admitted at full pressure into the cylinders, but shut off at an earlier period, propelling the pistons the remainder of the stroke by its elastic force, similar to driving a timepiece by the uncoiling of the main-spring.

Lastly. A combination of dimensions and proportions have been gleaned from the best results of locomotive engines of various constructions, and in use in different parts of the country. The driving wheels are six feet diameter, length of the stroke two feet, diameter of cylinders twelve inches, inside dimensions of fire box three by three and a half feet, tubes ninety-four in number by nine and a half feet long and two inches diameter. The general diminution of machinery in the construction has given room for ample dimensions in the principal working parts, and thus the whole arrangement has a close bearing on *safety, simplicity, accessibility, and economy.*

Circumstances led to those engines being ordered of Messrs. Shepherd and Todd, Railway Foundry, of this town. The Hull and Selby line was opened with the engines of the former order, but the public and the Company being so much annoyed by hot cinders from their chimneys, burning whatever they lighted upon, and rapidly destroying the smoke-boxes themselves, three of those engines were altered, and succeeded to a considerable extent in diminishing the nuisance, whilst the engines performed better and with less fuel. That fact,

however, being questioned, and two engines of the *improved* construction having got to work, Mr. John Gray, the engineer of the locomotive department, and patentee of the improved engines, urgently requested a most rigorous and simultaneous trial of the different engines, and to be witnessed for the parties concerned by persons above suspicion. Mr. J. Miller and Mr. T. Lindsley represented Messrs. Fenton, Murray, and Jackson; Mr. J. Craven and Mr. J. Barrons represented Messrs. Shepherd and Todd; and Messrs. E. Fletcher, W. B. Bray, J. G. Lynde, jun., J. Farnell, and J. Gray, were the representatives of the Hull and Selby Railway Company. The arrangements for the experiments were, that the gross load should include engine, tender, carriages, and everything in the train.

The steam was got up in the respective engines to the pressure of from fifty-six to sixty-six pounds per square inch; the fires filled to a certain level at the starting in the morning, and filled to the same level on finishing the last trip at night. The pressure of steam at starting was generally up to sixty-six pounds, and was at about half that pressure at the end of each trip. There were *fifty* experimental trips made in all, namely, twenty-four trips with the *Collingwood*, *Andrew Marvel*, and *Wellington*, the unaltered engines of Messrs. Fenton, Murray, and Jackson. Their average gross load was 53.4 tons, or 1,656 tons, over one mile: consumption of coke 1,013 lbs., or 0.611 lbs. per ton per mile; water 6,500 lbs., or 3.90 lbs. per ton per mile. There were ten trips made with the other three engines of Messrs. Fenton, Murray, and Jackson, which were altered at Hull, namely, the *Exley*, *Kingston*, and *Selby*. Their average load was 49.16 tons, or 1,524 tons over one mile; consumption of coke 635 lbs., or 0.416 lbs. per ton per mile; water 4,264 lbs., or 2.79 lbs. per ton per mile.

The *patent* engines made by Messrs. Shephard and Todd, viz. the *Star* and *Vesta*, made sixteen trips, and their average loads, &c., were 55.4 tons, or 1,718 tons over one mile; coke consumed, 465 lbs., or 0.271 lbs. per ton per mile; water 2,874 gals., or 1.62 lbs. per ton per mile. The average gross load of all the fifty trips is 53.2 tons, or 1,649.4 tons over one mile, and taking that as a standard load, the consumption of fuel and water performing exactly equal quantities of work, is represented in the following table:

Class of engines.	Load in tons conveyed over one mile.	Elsecar coke used per trip of 31 miles in lbs.	Coke used per mile in lbs.	Coke used per ton per mile in lbs.	Water used per trip of 31 miles in lbs.	Water per mile in lbs.	Water per ton per mile in lbs.
Patent . .	1649.4	446.98	14.41	0.271	2672	86.19	1.62
Altered . .	1649.4	686.15	22.13	0.416	4601.8	148.43	2.79
Unaltered .	1649.4	1007.78	32.59	0.611	6432.6	207.5	3.90

The financial annual result of the three classes of engines for coke

and boilers, with such a traffic as that of the Hull and Selby line, will be about—

4,500*l.* for the unaltered engines,
3,250*l.* for the altered do.; and about
2,000*l.* for the patent engines.

In conclusion, it is deserving of remark, that *all* the attesting witnesses expressed themselves highly satisfied with the manner in which the experiments had been conducted, and with the facilities which the Company so readily granted to enable them to come at correct results. Probably no experiments were ever made under similar circumstances where the parties concerned displayed greater independence, impartiality, and good feeling, than on the present occasion.—*Leeds Mercury.*

Mech. Mag., November, 1840.

An Account of the actual State of the Works at the Thames Tunnel (June 23, 1840.) *By* M. I. Brunel, M. Inst. C. E.

In consequence of local opposition, the works have not advanced much since the month of March, 1840; but, as that has been overcome, and facilities granted by the city, the works will be speedily resumed, and the shaft on the north bank commenced.

The progress of the Tunnel in the last year has been, within one foot, equal to that made in the three preceding years. During those periods collectively, the extent of the Tunnel excavated was 250 feet 6 inches, and during the last year the excavation has been 249 feet 6 inches. This progress has been made in spite of the difficulties caused by the frequent depressions of the bed of the river. These have been so extensive that in the course of twenty-eight lineal feet of Tunnel, the quantity of ground thrown upon the bed of the river, to make up for the displacement, in the deepest part of the stream, has been *ten times* that of the excavation, although the space of the excavation itself is completely replaced by the brick structure. On one occasion the ground subsided, in the course of a few minutes, to the extent of thirteen feet in depth over an area of thirty feet in diameter, without causing any increased influx of water to the works of the Tunnel. The results now recorded confirm Mr. Brunel in his opinion of the efficiency of his original plan, which is "to press equally against the ground all over the area of the face, whatever may be the nature of the ground through which the excavation is being carried." The sides and top are naturally protected; but the face depends wholly for support upon the poling boards and screws. The displacement of one board by the pressure of the ground might be attended with disasterous consequences; no deviation, therefore, from the safe plan should be permitted.

The paper is accompanied by a plan, showing the progress made at different periods. It is stated that a full and complete record of all the occurrences which have taken place during the progress has been kept, so as to supply information to enable others to avert many of the difficulties encountered by Mr. Brunel in this bold yet successful undertaking.

Ibid.

LUNAR OCCULTATIONS FOR PHILADELPHIA, MAY, 1841.

COMPUTED BY JOHN DOWNES.

Angles reckoned to the right or westward round the circle, as seen in an inverting telescope.

☞ For direct vision add 180°. ☜

Day.	H'r.	Min.	Star's name.	Mag.	From Moon's North point.	From Moon's Vertex.
3	6	12	Im. 75 Virginis,	6	16°	330°
3	7	1	Em.		275	234
7	16	26	Im. *y* Ophiuchi,	6	60	86
7	17	32	Em.		315	352
10	16	17	Im. 351 Sagittarii,	6	133	129
10	17	42	Em.		278	293
23	7	43	Im. *m* Geminorum,	6	79	136
23	8	37	Em.		232	286
25	9	28	Im. 82 Cancri,	6	79	132
25	10	20	Em.		220	273
25	9	33	Im. π^2 Cancri,	6	94	147
25	10	20	Em.		210	280

Meteorological Observations for February, 1841.

Moon.	Days	Therm. Sun rise.	Therm. 2 P.M.	Barometer. Sun rise.	Barometer. 2 P.M.	Wind. Direction	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inch's	Inch's			Inches.	
	1	32	40	29.80	29.60	E.	Moderate.	.67	Cloudy—rain and sleet.
	2	29	36	.70	.75	W.N.W.	do.		Partially cloudy—par. cloudy.
	3	34	38	.60	.50	W.	do.		Partially cloudy—par. cloudy.
	4	24	32	30.14	30.15	W.	do.		Clear—clear.
⊙	5	22	38	.03	29.92	N.E.	Calm.		Clear—clear.
	6	31	43	29.84	.86	N.E.N.	do.		Lightly cloudy—cloudy.
	7	32	32	.88	.94	N.	Moderate.		Partially cloudy—snow.
	8	24	35	30.14	30.18	W.	Calm.		Clear—partially cloudy.
	9	30	33	.00	29.83	N.E.	do.	.30	Cloudy—snow.
	10	19	31	29.73	.72	N.	do.		Clear—flurry of snow—clear.
	11	8	16	.89	.84	W.	Moderate.		Clear—clear.
	12	3	12	.88	.84	W.	do.		Clear—flying clouds.
☽	13	7	17	.79	.78	W.	Brisk.		Clear—clear.
	14	13	27	.77	.77	W.	Moderate.		Fleecy clouds—hazy.
	15	13	22	.72	.81	N.W.	blustering		Clear—hazy.
	16	16	33	.90	.85	W.	Moderate.		Clear—do
	17	27	37	.60	.60	E.	do.		Cloudy—lightly cloudy.
	18	21	31	.93	.98	N.	do.		Cloudy—cloudy.
	19	28	37	.60	.55	W	do.		Clear—cloudy.
	20	23	39	.70	.63	W.	blustering		Clear—clear.
⊗	21	29	50	.50	.49	W.	Moderate.		Clear—cloudy.
	22	24	44	.50	.50	S.W.	do.		Cloudy—hazy.
	23	35	45	.35	.35	E.W.	Brisk.		Clear—cloudy.
	24	21	25	30.05	30.05	W.	Moderate.		Cloudy—snow.
	25	18	33	.10	.10	E.	do.		Clear—lightly cloudy.
	26	32	47	.00	.10	W.	do.		Cloudy—clear.
	27	40	41	29.60	29.60	E	do.	.15	Cloudy—rain.
☾	28	32	50	.85	.86	S.W.	do.		Clear—clear.
	Mean	23.97	34.07	29.81	29.79			1.12	

	Thermometer.		Barometer.	
Maximum height during the month,	50.00	on the 21st and 23th.	30.18	on the 8th.
Minimum "	3.00	on the 12th.	29.35	" 23rd.
Mean	29.02		29.80	

METEOROLOGICAL REPORT

FOR THE STATE OF PENNSYLVANIA,

Collated from returns made to the Committee on Meteorology of the Franklin Institute of the State of Pennsylvania, for

APRIL, 1841.

	County.	Town.	Observer.	Thermometer. 7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum.	Mean.	Days omitted.	Register. Lowest.	Mean.	Days omitted.	Barometer. 7, A. M.	2, P. M.
1	Philadelphia,	Philadelphia,	G. P. Schively,	46.09	53.40	47.56	66.00	31.00	49.02	2 2/3	27.50	40.42	.	29.87	29.9
2	Montgomery,														
3	Bucks,	Newtown,	L. H. Parsons,	41.93	50.90	43.47	65.00	27.50	45.43	.	24.50	37.79	.	29.93	29.9
4	Lehigh,														
5	Northampton,	Easton,	Charles Elliot,												
6	Monroe	Stroudsburg,	A. M. Stokes,	38.11	48.94	.....	63.00	29.00	43.52	18 1/3	....	....	.	29.19	29.0
7	Pike,	Milford,	Ralph Bull,												
8	Wayne,	Hone-dale,	W. Richardson,												
9	Susquehanna,	Silver Lake,	E. Rose,	38.93	48.63	42.93	73.00	27.00	43.50	.	26.00	35.73	.	28.03	28.0
10	Luzerne,	Wilkesbarre,	V. L. Maxwell,	41.37	52.62	43.80	74.50	28.00	45.92	1 1/3	22.50	38.68	13	29.34	29.2
11	Schuylkill,	Port Carbon	P. C. Lyceum,	40.97	54.96	40.20	77.00	29.00	45.38	2/3	20.00	34.90	.	29.29	29.2
12	Berks,	Reading,	C. F. Egelmann,												
13	Chester,	West Chester,	Wm. W. Jeffris,	43.46	53.12	46.92	68.25	30.00	47.83	4	26.00	37.59	4	29.41	29.4
14	Delaware,	Haverford,	Haverford School,												
15	Lancaster,	Lancaster,	Conservatory of Arts,	45.02	55.64	46.22	70.00	31.50	48.96	2/3	29.00	40.55	.	29.43	29.4
16	York,														
17	Lebanon,														
18	Dauphin,	Harrisburg,	J. Heisely,	45.44	53.30	50.36	66.00	34.00	49.70	2 2/3	30.00	41.70	.	29.71	29.6
19	Northumberland,	Northumberland,	Andrew C. Huston,	43.28	53.53	46.23	70.00	31.00	47.68	.	23.00	35.70	.	29.40	29.3
20	Columbia,	Danville,	C. H. Frick.												
21	Bradford,														
22	Tioga,														
23	Lycoming,														
24	Union,														
25	Mifflin,														
26	Juniata,	Mifflintown,	J. A. Kinkead,	40.38	55.93	43.84	75.00	24.00	46.32	1 1/3	....	....	.	29.41	29.41
27	Perry,														
28	Cumberland,	Carlisle,	Prof. W. H. Allen,	42.83	50.29	43.32	67.00	29.00	45.48	1 1/3	27.00	38.53	.	29.34	29.30
29	Adams,	Gettysburg,	Prof. M. Jacobs,	42.00	53.71	45.18	69.00	29.00	46.97	.	26.00	37.87	.	29.34	29.33
30	Franklin,														
31	Huntingdon,	Huntingdon,	Prof. Jacob Miller,	41.90	57.25	46.50	77.00	29.00	45.55	2/3	....	....	.	29.31	29.23
32	Centre,	Bellefonte,	John Harris,												
33	Potter,														
34	M'Kean,	Smithport,	M. R. Atkins,	35.72	46.87	39.10	71.00	22.00	40.56	2/3	20.00	37.33	6	....	....
35	Clearfield,														
36	Cambria,	Ebensburgh,	Richard Lewis,	35.85	49.15	38.40	71.00	21.00	41.43	1	18.00	33.30	.	27.87	27.81
37	Bedford,	Bedford,	Samuel Brown,	41.51	53.88	45.07	77.50	27.00	46.82	1	....	....	.	29.18	29.13
38	Somerset,	Somerset,	George Mowry,	39.06	50.93	42.86	74.00	20.00	44.28	3 1/3	23.00	35.16	2	27.81	27.73
39	Indiana,	Indiana,	Richard White,												
40	Jefferson,	Rose Cottage,	C. C. Gaskell,												
41	Warren,	Warren,	J. E. King,	43.87	55.73	39.00	85.00	23.00	46.20	.	....	....	.	28.63	28.64
42	Venango,	Franklin,	Wm. Connely,	.....	...	.....	.....	....	.....	.	....	....	.	28.83	28.92
43	Armstrong,														
44	Westmoreland,														
45	Fayette,	Uniontown,	J. P. Weethee,												
46	Green,														
47	Washington,	Cannonsburg,	Prof. A. H. Campbell,												
48	Alleghany,	Pittsburgh,	J. P. Bakewell,	45.37	52.17	.....	82.00	32.00	48.77	10 1/3	....	....	.	29.21	29.16
49	Beaver,	Beaver,	James Allison,												
50	Butler,	Butler,	Jacob Mechling,	41.60	52.00	47.77	77.00	26.00	47.12	.	....	....	.	28.75	28.73
51	Mercer,	West Greenfield,	S. Campbell,												
52	Crawford,	Meadville,	David Dick,	37.73	51.53	38.67	83.00	21.00	42.64	.	17.00	31.40	.	28.81	28.76
53	Erie,	Erie,	Park & Reid,												

r.				Barometer.							Weather.											
Days omitted.	Register. Lowest.	Mean.	Days omitted.	7, A. M.	2, P. M.	9, P. M.	Maximum.	Minimum	Mean.	Days omitted.	Clear.	Cloudy.	Days omitted.	Rain.	Snow.	Rain and Snow.	Thunder Showers.	Rain in inches.	North.	N. N. E.	N. E.	
2⅔	27.50	40.42	.	29.87	29.95	29.94	30.50	29.10	29.92	2⅓	13	14⅔	2⅓	15	4	2	1	.....	⅔	1	6⅓	
.	24.50	37.79	.	29.93	29.92	29.91	30.46	29.02	29.92	.	10	19⅔	⅓	16	2	1	1	5.470	⅓	⅔	6⅔	
18⅓	....	....	.	29.19	29.07	.....	29.68	28.06	29.13	18⅓	2	9⅔	18⅓	....	....	. ..	..	.....	1	⅔	2	
.	26.00	35.73	.	28.03	28.03	28.03	28.37	27.10	28.03	.	12⅓	17⅔	.	4	1	....	2	2.115	4⅔	.	.	
1⅓	22.50	38.68	13	29.34	29.25	29.30	29.79	28.45	29.30	1⅓	9⅓	18⅓	2⅓	13	2	2	..	.....	3⅓	.	6	
⅔	20.00	34.90	.	29.29	29.29	29.23	29.71	28.57	29.27	⅔	10⅔	18⅔	⅔	8	1	2	1	4.297	1⅓	1	3	
4	26.00	37.59	4	29.41	29.40	29.37	29.64	28.54	29.39	4	6⅔	19⅓	4	11	4	....	1	4.819	3⅓	1⅓	3⅓	
⅔	29.00	40.55	.	29.43	29.41	29.41	29.94	28.53	29.42	⅔	11⅓	18	⅔	11	2	1	1	3.957	1⅔	1⅔	2⅓	1
2⅔	30.00	41.70	.	29.71	29.69	29.68	30.19	28.89	29.68	2⅓	.	.	.	7	3	....	1	4.472	3⅔	.	⅔	
.	23.00	35.70	.	29.40	29.36	29.38	29.89	28.51	29.38	.	5⅔	24	⅓	14	2	1	..	4.424	4	.	5⅔	
1⅓	....	....	.	29.41	29.41	29.40	29.93	28.53	29.41	1⅔	7	21⅓	1⅔	11	2	....	..	5.030	.	.	2⅔	
1⅓	27.00	38.53	.	29.34	29.30	29.33	29.81	28.56	29.32	1⅓	8	20⅔	1⅓	9	3	....	..	4.902	1⅓	1	2⅓	1
.	26.00	37.87	.	29.34	29.33	29.32	29.86	28.55	29.33	.	11⅓	18⅓	.	9	2	1	1	4.679	3	1⅓	4⅓	
⅔	....	....	.	29.31	29.23	29.27	29.73	28.53	29.27	⅔	17	13	.	8	2	....	..	4.891	.	.	.	
⅔	20.00	37.33	6	....	....	....	....	....	....	.	8⅓	20⅓	1⅓	9	3	....	..	.. ...	2⅔	.	.	
1	18.00	33.30	.	27.87	27.81	27.82	28.81	27.06	27.83	1	6⅔	22⅓	1	8	3	....	..	2.781	1⅔	.	1⅓	
1	....	....	.	29.18	29.13	29.14	29.62	28.39	29.15	1	9⅔	19⅓	1	9	2	....	..	.....	1	⅔	⅔	
3⅓	23.00	35.16	2	27.81	27.73	27.81	28.20	27.10	27.78	2⅓	8	19⅔	2⅓	8	3	2	..	2.541	⅓	.	2	
.	....	....	.	28.63	28.64	28.64	28.98	28.00	28.64	.	5⅓	24⅔	.	9	....	....	..	2.033	1⅔	.	1⅓	
.	....	....	.	28.83	28.92	28.87	29.41	28.10	28.87	3	.	.	.	9	....	....	..	1.990	.	.	.	
10⅓	....	....	.	29.21	29.16	29.17	29.69	28.41	29.18	⅓	9	20	1	10	....	4	1	3.492	.	.	2	
.	....	....	.	28.75	28.73	28.70	29.20	28.00	28.73	.	.	.	.	13	2	....	..	4.207	⅓	.	2⅓	
.	17.00	31.40	.	28.81	28.76	28.77	29.30	28.04	28.78	.	8⅓	21⅔	.	9	1	1	..	.....	4⅔	.	.	

Winds.																	Hygrometer.					
North.	N. N. E.	N. E.	E. N. E.	East.	E. S. E.	S. E.	S. S. E.	South.	S. S. W.	S. W.	W. S. W.	West.	W. N. W.	N. W.	N. N. W.	Calm.	Days omitted.	Dew-point.	Days omitted.	Diff. therm. and dew-point.	Wet Bulb.	Days omitted.	No. of Report.
2/3	1	6 1/3	1/3	.	.	2 2/3	.	2 1/3	1	4	1/3	2	1/3	4 2/3	1	.	3	....	.	.....	....	..	1450
1/3	2/3	6 2/3	.	1/3	1/3	2/3	1/3	1	1/3	4 1/3	1	2 2/3	1/3	9 1/3	2/3	.	2/3	....	.	.....	....	..	1521
1	2/3	2	.	1 1/3	.	.	2/3	1/3	2/3	1	.	1 2/3	.	3	.	.	17 2/3	....	.	.....	....	..	1467
4 2/3	.	.	.	.	.	1 2/3	.	1/3	.	4 2/3	.	10	2/3	8	.	.	.	....	.	.....	....	..	1504
3 1/3	.	6	.	1/3	.	1 1/3	.	1/3	1/3	7	.	1	.	4 2/3	.	2/3	4 1/3	....	.	.....	....	..	1463
1 1/3	1	3	.	2	.	2	1/3	1/3	1/3	.	.	6	.	4	2 1/3	6	1/3	....	.	.....	....	..	1458
3 1/3	1 1/3	3 1/3	.	1	1/3	1	1/3	1 1/3	2	1	1/3	2	1 1/3	7 1/3	.	.	4	....	.	.....	....	..	1456
1 2/3	1 2/3	2 1/3	1	2	1 1/3	2	2	2 1/3	1 2/3	1	1 1/3	1 2/3	1 2/3	4	1 2/3	.	2/3	44.83	3	.....	49.94	3	1470
3 2/3	.	2/3	.	.	.	6 1/3	.	4 2/3	.	2 1/3	.	2/3	.	9 2/3	.	.	2	....	.	.....	....	..	1454
.	.	5 2/3	.	2 1/3	.	3 1/3	1/3	2	.	2	.	4 2/3	1/3	4	1/3	1	.	....	.	.....	51.73	..	1461
	.	2 2/3	.	1	.	4	.	.	.	2	.	1 2/3	.	7	.	10 1/3	1 1/3	....	.	.....	....	..	1451
1/3	1	2 1/3	1 1/3	1 1/3	1/3	1	1/3	2 1/3	.	2 1/3	1/3	2	3	3 2/3	1/3	5 2/3	1 1/3	40.08	18	.....	47.17	18	1452
	1 1/3	4 1/3	2/3	2/3	.	2/3	2/3	5	2/3	3	1/3	1 1/3	2/3	5 1/3	1/3	1 2/3	.	42.87	4	.....	50.25	4	1525
	.	.	.	10	.	.	.	.	.	.	.	19 1/3	.	.	.	.	2/3	....	.	.....	....	..	1475
2 2/3	.	.	.	4	.	5 1/3	.	3	.	4 1/3	.	8 1/3	.	1	.	.	1 1/3	....	.	.....	....	..	1476
2/3	.	1 1/3	.	2	.	3	.	1 2/3	.	5 2/3	.	8 1/3	.	3 2/3	1/3	1 2/3	1	....	.	.....	...	..	1462
	1/3	2	2/3	2/3	.	3 1/3	2/3	3	1 1/3	5 2/3	1 1/3	2/3	4	8 2/3	2	.	1	....	.	.. .	....	..	1453
1/3	.	2	1/3	2 2/3	.	2	.	3	.	3 1/3	1 1/3	4	2	1	1/3	5	2 1/3	....	.	.....	....	..	1460
2/3	.	1 1/3	.	1 1/3	.	3 1/3	.	3 1/3	.	4 2/3	.	5	.	3 2/3	.	5 2/3	.	....	.	.....	....	..	1471
	.	.	.	.	.	8 2/3	.	1/3	.	3 1/3	.	1	.	13 2/3	.	.	3	....	.	.....	....	..	1466
	.	2	.	1 2/3	.	3 2/3	.	1 1/3	.	3	.	2/3	.	6 2/3	.	6	5	....	.	.....	....	..	1468
1/3	.	2 1/3	.	10	.	.	.	1/3	1/3	8 1/3	.	6	.	2 1/3	.	.	.	....	.	.....	....	..	1482
1 2/3	.	.	.	1	.	1 1/3	.	5 2/3	.	2	2/3	3 2/3	.	4 2/3	.	.	6 1/3	....	.	.....	....	..	1465